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HOME HANDY-MAN

BY

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WITH NUMEROUS ILLUSTRATIONS IN THE TEXT

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HOME HANDY-MAN

Decorations and Repairs for the Home Worker

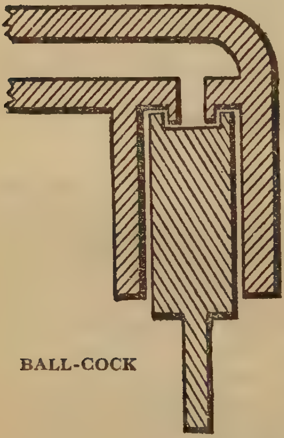
BALL-COCK TO CISTERN.—In most modern houses the supply of cold water to the boiler of the kitchener or to the independent boiler comes from a tank in the roof, fed from the mains by way of a ball-cock. The same tank may supply the bath and w.c.'s. The purpose of the ball-cock is to shut off the supply at the inlet pipe when the water rises to a suitable and sufficient level in the tank—and to allow more to enter when the level drops as water is drawn from the tank.

The valve itself is a plunger, bearing a rubber or fibre washer in its cupped upper end. At the lower end is a yoke through which passes a lever hinged to the valve, at the end nearest the tank, and bearing a watertight copper ball at the farther end. The float is moved up as water rises in the tank and ultimately lifts the plunger and seals the inlet opening in the valve nozzle. In the course of a few months or more, the valve-washer may have deteriorated and the valve will no longer shut off completely. Water will rise until it flows out through the overflow pipe. This is a warning that the valve must be attended to and a new washer fitted.

Shut off the water in the main at the stop-cock outside the house if one is not also provided inside. Then take out the split-pin that forms the pivot for the lever arm, draw out the lever and ball, and pull down the plunger of the valve. The pin may need closing at its expanded

end with a pair of pliers before it will come out. Push a small bradawl in the loop and pull it out by this. With the plunger as a pattern a new washer can be bought at the ironmonger's, and the plunger and lever replaced. The pin may need a little attention before it is put back, if it has become distorted in withdrawing it. Open the split end of the pin slightly after the lever has been replaced, to prevent it working out.

If the hollow ball should leak at the joint or elsewhere it will not function properly as a float, but will take in water and become "drowned" or submerged. The remedy is to unscrew it and replace it with a new ball of the same size. The handyman who can manage soldering jobs can try to repair the ball, first emptying it of water. If the leak is a mere pin-hole it can be enlarged in order to get the water out. Then clean up the copper around the hole and run in some solder with a copper-bit. A larger hole will need a copper patch sweated on. Copper conducts the heat away very quickly, so that a well-heated "iron" should be used and the site of the leak warmed up before attempting to proceed with the filling of the hole. Try the ball in water before replacing it.



BALL-COCK

There is to be found in w.c. cisterns a similar kind of ball-valve, which needs adjustment from time to time in order to allow enough water to enter, or on the other hand, to prevent overflow. If the water overflows, carefully bend down the lever so that the float shuts off earlier. If too little water enters before the shut-off, reverse the process by straightening the lever, which will delay the shut-off. The same method, of course, may be used with the valve in the roof cistern if it overflows and the fault is not in the washer or the float.

Another trouble that may be met with is a vibration or chattering of the valve when water is entering the cistern. Sometimes this may produce a musical note, the sound being conducted through the pipes to different parts of the house. A remedy is to turn down the stop-cock on the rising main until it is at about half-way. Fitting a larger ball to the lever sometimes cures the trouble, which is caused by the high pressure of the water in the supply main.

When it is desired to empty the tank and the water cannot be turned off at the main, the lever may be slung up in the "shut" position by a cord fastened to it, and going to a nail or a rafter overhead. Examine the valve in frosty weather, to make sure that the ball has not been trapped in ice on the top of the valve.

BATHROOM HINTS AND WRINKLES.—Rusting of a bath is often due to dripping taps, and these should be looked to, new washers being fitted as soon as any signs of faulty action appear. No abrasive cleaners should be used to remove marks on the bath, but merely soap and hot water. The scouring and cleaning powders sold depend usually on friction with some gritty material, and this damages the surface of the enamel.

Re-enamelling a Painted Bath.—This is worth while if the old surface is not too badly marred. If, however, there are many bare places right through to the metal, and extensive rusting, it is almost impossible to make a satisfactory job, as the defects may show in spite of over-painting. The first task is to wash the surface with soap and hot water, and here the use of a scouring powder is permissible. Rinse the bath and dry the surface thoroughly, when it may be rubbed down with sand-paper, proceeding from coarse to fine. Bad places need especial attention, to remove all traces of rust, or this will work through after painting.

There are many brands of enamel sold especially for the job under consideration, and methods of application differ slightly in detail. Two sorts are needed, first the under-coating, a flat or non-glossy one, and then the enamel itself. With a small brush carefully fill up the bare places, taking care not to overrun them. The aim is to level up the surface, and if the enamel is allowed to spread on to adjacent parts it will make the defect show

more, instead of concealing it. Allow three days for this to harden, and then rub down the edges with fine paper if there has been any "spread." Next paint the whole surface with undercoating, taking care to go once only over each portion without overlap. Allow three days for setting and repeat with a second undercoat.

After three days the worker may proceed to apply the finishing coat, of glossy enamel, and here also care is needed not to get "runs" and "drops." Work of this kind should not be done in hot weather or, on the other hand, in cold or frosty. The places around taps, overflow, and waste must be dealt with neatly. If water can be shut off entirely from the bath supply during the painting, this will be an advantage; failing this, see that taps are drip-proof before commencing operations, and sling a can or a jam-jar beneath each tap to "make assurance doubly sure."

The glossy coat should be allowed a week to dry and harden, and until the paint is dry the bath should be protected from dust. Dust-raising operations near the bathroom should be discouraged, and the door kept closed. It may occasion surprise that nothing has been said about the new cellulose finishes that are so handy in many home-beautifying jobs. These are extremely useful in painting new work, but when applied to old painted surfaces there is always some uncertainty as to the result. Cellulose "enamels" are of course on a different base entirely from lead paints, and that is why they may not "take" over the latter.

Bath Taps.—With a white and glossy bath, the old brass taps look shabby. What can we do to brighten them? If funds allow, a pair of new, chromium-plated ones can be bought for a sovereign or twenty-five shillings. Failing this we can enamel the taps white or cream, using one of the special paints sold for the purpose. The cleaning and preparation ought to be taken in hand at the time that the bath itself is cleaned, before the latter is painted. A new waste plug and chain will help to brighten up the bath, and the plug had better be a hard rubber one.

Electric Fittings.—No portable electric appliance should be taken into the bathroom. If touched with wet hands, or if such a fitting falls into the water when

a person is bathing, a fatal shock may result. In some older houses the switch of the bathroom light has a metal cover and tumbler. This also is a source of danger, and a new switch with non-conducting cover and tumbler should be substituted. Special rules and regulations have been framed by the I.E.E. to guard against the danger of electrical leakage in bathrooms.

Waste Traps.—Beneath both the bath and the wash-basin will be seen a U-shaped trap that contains water to seal off the pipe against gases that might rise up from the drains. In the side or at the bottom of the trap is a screw plug. In case the waste becomes obstructed this plug may be taken out and the trap cleared with a hooked wire. Do not forget first to place a pail beneath the trap. The bath trap may be too close to the floor for a pail to be used, in which case a pan can be placed beneath to catch water that will trickle or pour out when the plug is removed. If the washer on the plug is faulty, fit a new one. If the plug leaks, a little red lead may be smeared round the thread.

BATH WASTE

BELLS.—The old-fashioned mechanical door-bells are now seldom met with, though here and there a "pull" has been converted to operate an electric bell. The name "bell-hanger" to-day has no significance, for bells are no longer hung. Not all are electric, however, for in the many small houses that have been built in recent years a clockwork or spring bell attached to the door itself is quite satisfactory. These can be bought very cheaply, and the fixing is simplicity itself. The push is screwed to the outside of the door-frame and a hole drilled through for the rod that actuates the mechanism. The latter, contained within the gong itself, is fastened to the inside of the door.

In clockwork bells the gong has to be twisted a number of times to wind up the spring; when the push is depressed it permits the motion-work to turn and vibrate

the hammer. The daily wind-up must not be omitted, or the bell will get a bad name. Another type of bell needs no winding, for the actual pressing of the button vibrates the hammer by means of a quadrant, wheels and pinions, as in a bicycle bell. Both kinds of bell are liable to stoppage through the sticking of the rod in the hole. If the hole was not large enough in the first place, the swelling of the wood may have caused the rod to stick.

The remedy is to enlarge the hole with a gimlet. Another cause of sticking may be lack of register between the hole in the push plate and that in the bell movement inside the door. Perhaps the holes were not directly opposite in the first place; or screws in one or other fitting may have come loose and allowed the plates to shift. Take out the screws, put a little plastic wood into the holes or plug them, and screw up tightly and evenly. If the plates do not register, one must be moved until they come opposite.

Electric Bells.—The most frequent cause of stoppage is a spent battery. When a cell begins to get feeble it will be uncertain in its response: on days that the bell is little used it may ring loudly, but the more frequent its use the weaker will be the sound. A new dry cell or cells must be provided, or if it is a wet battery that furnishes the current, it must be refilled with solution, or perhaps the zinc replaced by a new one.

If the battery seems in order and the bell will not ring, look at the push and see that it makes good contact. Then go over the circuit and make sure it is uninterrupted and that no wires are broken, or have come away from terminals. Test the connections with the finger: a wire may look all right but be broken or corroded through close to the screw. Failing other cause the trouble may be merely want of adjustment of the interrupter. A turn of the contact screw may be needed to bring the latter nearer the spring. A very minute alteration is usually needed, and too close setting will stop the bell.

Ample battery power should be allowed, at least two cells being provided, for instance, for a single bell that rings in the kitchen from a push located at the front door. Such a bell may probably work with one cell only, but much more vigorous ringing and longer service will result from the extra battery power suggested.

Wiring a Bell Circuit.—The best place for the battery is on a shelf near the bell, or in a cupboard near the front door, whichever is most convenient. The wires can be taken along and above the picture rail, where they can be fixed at intervals with insulated staples. Twin bell wire is used, and the outer covering must be carefully slit and unwrapped for a few inches, one wire being cut for the bell contacts. At the push, an end of each wire is connected to the terminals, and the same at the battery. The two wires are distinguished by different colours in the covering; or by one being white and the other having a coloured thread.

One wire thus goes direct from battery to push, and the other is cut to take in the bell, and then goes to the other terminal of push. The push contacts are open, and no current flows, until the button is pressed. Then, however, the gap in the circuit is bridged, and current goes from battery by way of push to bell and thence returns to battery.

BOILERS, FOR WATER HEATING.—Ranges and certain of the combined warming and cooking stoves have a built-in boiler at the back for heating water. The boiler has only a small capacity, of course, and a quick and vigorous circulation is necessary to warm the contents of the 20-gallon tank usually fitted. It is an axiom that an apparatus designed to do three or four jobs will not perform them all with equal thoroughness. The chief function of a kitchen range is to cook, and when it is being used for that purpose heat is obviously diverted from its other purpose of heating water. So we must use it mainly for only one function at a time, and if cooking is most important at the moment, then we may not get a quick and ready supply of hot water.

This applies even mcre to the combined sitting-room grates that cook, heat water, and warm the room. When set for the latter purpose the dampers usually prevent much of the heat from being absorbed by boiler or oven; though in a living-room such a combination grate is often a convenience. Generally speaking, the use of a range boiler is a somewhat expensive means of getting hot water, and a coke-fired independent boiler will probably save its cost in fuel if a plentiful and ready supply of hot water is needed. An advantage of the

independent boiler is that if large enough it can be arranged to heat a radiator without unduly depleting the hot-water supply or burning much more fuel.

Coming back to the range boiler, the handyman who has one in his kitchen can get more efficient service out of it by proper care and attention. Almost the first thing to suspect if water supply is defective is a furred-up boiler, assuming the flues and dampers to be all in order. The pipes also may be partly choked with deposit, but the boiler can be dealt with more simply than these. It must be cleaned out. This is scarcely a job for the handyman himself and he will have to employ a skilled mechanic. If an old-fashioned kitchen range fails to give hot water and is wasteful and expensive in cooking, it is best to scrap it and put in a portable self-setting range that need not be built-in. These are made in various sizes, and there is no point in buying an unnecessarily large one. When a big double-oven kitchener is removed the opening can be bricked up at the sides to leave a 3 ft. recess, which would accommodate a portable range big enough for the average small family. On the other hand, one might leave the opening larger, and install alongside the new smaller range a gas-fired water heater, by-passed to the hot-water system, so that during the warmer months the range need not be used. The gas appliance is quite a small one, as it needs no storage tank other than the one served by the range boiler.

Sometimes in the case of combination grates the flow and return pipes for hot water are taken through the chimney breast horizontally and then up vertically to the ceiling, the pipes being enclosed by a wooden casing. In such an installation known to the writer, the cement around pipes failed to seal the hole in chimney breast, and fumes from the grate made their way out into casing, travelled up the latter to the space under floor, and escaped into a bedroom above. This is a cause that may be suspected if fumes are detected in a first-floor room, though another cause of quite a different kind may be responsible—down-draught from the bedroom chimney carrying down gases from an adjacent one.

Some manufacturers of boilers make a point in their advertising matter that the appliance will burn rubbish and household refuse. So it may, but you must feed it

also with something of a greater calorific value if you demand hot water, and the refuse must be fed in when there is a good clear fire in the furnace. As well might one expect to produce pork by feeding pigs on garbage as to heat water with odds and ends of rubbish and scanty fuel. Good quality clean broken coke (boiler nuts) is usually the best and cheapest fuel for independent boilers, and the same will do for the combined grates after the fire has been started with coal and drawn up red and bright. In the kitchener, cobbles or nuts are the fuel of choice. Some gas companies supply coke on contract at rates a little lower than the prevailing ones charged by coal merchants, delivery being made as the householder requires.

The independent boiler is connected to the chimney by a cast-iron stove pipe. When the boiler stands anywhere but in a proper fireplace recess there are certain points to be observed that are sometimes overlooked or disregarded by builders. If the flue is built out from the wall the pipe goes up vertically for a few feet and then enters the flue by a bend. If the flue is built inwards the pipe goes up vertically direct into it or is connected to it by an obtuse-angled section. Sometimes the work is so badly done that the top bent section of the stove pipe is unsupported underneath and actually hangs by its hold in the flue, or by the adhesion of the cement, which latter does not last for long.

Owing to the jarring caused by stoking and cleaning, the pipe becomes loose at the top and is often a constant source of bother. The remedy is to provide a proper support for the pipe, which could be an iron band around it, bolted to a T-shaped iron stay which the local blacksmith would forge at small expense. The stay is fixed to the wall at a height to enable the band to embrace the socket of the elbow. The band, of stout iron, is drilled with a hole in each end, and these holes register with one in the end of the stay. When the band has been put round the pipe it is fixed to the stay by a stove-bolt which passes through the three holes.

Unless an iron wall-box has been provided in the brick flue the chimney cannot be swept without taking down the stove pipe. Such a cleaning aperture should always be built in when the flue is constructed, but builders often

omit it. It will pay the owner to have this done at the first opportunity so that the flue can be swept without bother. If the pipe has to be taken down for the half-yearly sweeping the flue of a kitchen boiler needs, it means that the cement joint is broken and must be made good on replacement. Then, too, the mouth of the opening may become chipped or otherwise damaged. A wall-plate or box fitted in the outer wall saves all this trouble and enables the sweep to put his brushes up the flue without mess or damage indoors.

An alternative form of stay can be done. This is in the form of a yoke which fits half-way round the socket of the pipe, and is continued in front by a separate half-hoop that is fastened to the yoke by two stove bolts. This is a much stronger arrangement, well worth the extra cost.

Hints on the care of boilers and hot-water systems in frosty weather are given in the article on FROST.

CEILING REPAIRS.—It may not be very often that the amateur finds himself called upon to mend a hole in a plastered ceiling, but since accidents are always likely to occur even in the best-regulated households, it is just as well that he should be able to save himself the expense of having a professional plasterer to do the job when occasion demands.

Perhaps the chief causes of damage to ceilings are leaks, bursts or the overflowing of cisterns; excessive vibration of the floor overhead, which may crack or loosen the plaster if the latter is very old; moving tall and heavy furniture, which, in the case of a low ceiling, is very likely to furrow or dent the plaster; and, most serious of all, inadvertently dropping a heavy weight between the joists of the ceiling above. The last-mentioned accident is not unlikely to occur when the amateur plumber, who is mending a leaky ball-valve or executing similar work in the loft, steps by accident upon the unboarded part of the floor. He may decide to look upon cure as the next best thing to prevention, and set about repairing the hole himself. He will probably find that a square foot or so of plaster has fallen, and that half a dozen or more laths need replacing.

For the most part, the tools which the amateur will require are easily made at home, they comprise a trowel, a brush (a worn-down distemper brush will do very well),

a mortar-board, a float, a plasterer's hawk, a hammer and a straight-edge. He will also require a pail, a tall step-ladder to enable him to work in comfort, and dustsheets to spread over the floor, furniture and decorations so as to prevent soiling by water or dropped plaster. If the ceiling is very lofty, it may be necessary to rig up a wide, stout plank supported by a trestle at either end, to enable the amateur to reach the job. In any work upon a ceiling it is essential that the workman should have conditions as comfortable as possible, if the job is to be done with any satisfaction. Old clothes or a long overall should be worn, the sleeves being tied above the wrists or secured with elastic bands, so as to prevent water from running up the arms; while the hair should be protected by a cap.

Necessary Implements.—The mortar-board may consist of the end of a strongly made butter box, such as can be obtained at the grocer's for a few pence; all projecting nails should be extracted. The straight-edge is a piece of ½-in. deal measuring about 2 ft. 6 in. by 4 in.; it should be planed perfectly true along the edges with a jack-plane. The float and hawk can be simply made in the following manner.

For the float, select a piece of straight-grained ¾-in. deal; it must be sawn to about 12 in. by 4½ in. and planed to a true surface on the side that is to face the work. The other side must be fitted with a looped wooden handle cut with a scroll-saw or bow-saw out of 1-in. wood. It is important, when marking this out, to allow sufficient room between the loop of the handle and the upper surface of the float for the insertion of the knuckles; 2 in. should be adequate. A glance at the illustration, Fig. 1, makes these instructions quite clear. The projecting ears of the handle should be screwed to the float, taking care that the points of the screws do not project on the other side or cause bulging of the surface through being too long, for the purpose of the float is to produce a perfectly smooth and level surface when worked to and fro over the surface of the wet plaster.

The hawk, upon which the plaster that has been mixed on the mortar-board is held while being used, is also made of ¾-in. stuff, but is square in shape—between 8 in. and

9 in. is a convenient size. To prevent warping from the contact of the wet plaster, it must have a ½-in. wooden batten screwed on underneath across the grain, as is shown in Fig. 2, which illustrates the plan of the underneath part of a hawk. The handle is a piece of quartering reduced to about 1½ in. each way in cross-section and long enough to fit comfortably into the fist. After the long arrises of the handle have been taken off, it is inserted into a hole cut to receive it in the batten, so that it fits

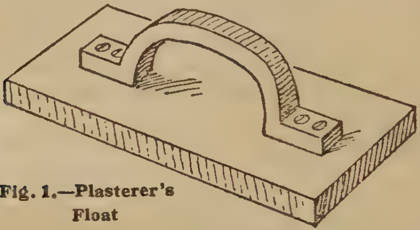


Fig. 1.—Plasterer's Float

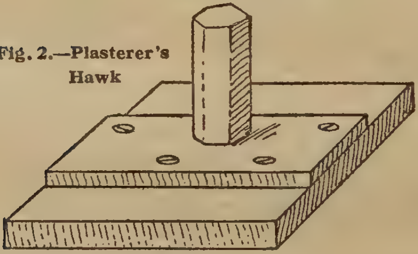


Fig. 2.—Plasterer's Hawk

against the underside of the board. It is tightly screwed with a single long screw from the upper surface of the hawk, the screw hole being deeply countersunk and afterwards filled up level with plastic wood.

For small jobs an ordinary bricklayer's trowel can be used when putting on the plaster, but for any extensive work involving "fine stuff" a plasterer's laying trowel is a necessity. This can be bought for a few shillings, and may be considered a justifiable purchase in the circumstances. The trowel, hawk and float should be washed clean of plaster after each time they are used. The former should not be allowed to get rusty, while the

float and hawk must not be allowed to lie in water for any length of time, or they will warp.

Preparation of Ceiling.—Having got together all the necessary tools, we come to the actual work of repairing the ceiling. Assuming the bigger job to include the less, we will describe a repair where not only is the plaster badly damaged, but a number of the laths have been split and broken as well. First clear away with a pointed trowel all the loose plaster round the margin of the hole, working the point of the tool into crevices and making all corners as rounded as possible. If the finer plaster at the surface has fallen away and left the coarser layers exposed, the latter must be hacked away so as to reveal the laths beneath it. Before any fresh plaster is applied, broken laths must be mended or replaced, and for this purpose they must be cleared of plaster as far back as the joist to which they are nailed.

Laths vary in thickness from less than $\frac{1}{8}$ in. to $\frac{3}{8}$ in., the most usual size for ceiling repairs being $\frac{1}{4}$ in., and each lath must be so laid that it is separated by $\frac{1}{4}$ in. from its neighbour in order to provide a good "key" for the wet plaster. A broken or splintered lath should be cut away with a chisel and hammer at the centre of the joist to which it is nailed, and replaced by a new strip cut to the correct length. This should be such that a space of $\frac{1}{4}$ in. or $\frac{3}{8}$ in. separates the ends of two laths that come against each other at the centre line of a joist. Moreover, no more than three such joints are to come together, but the laths must be "bonded" in groups of three, so as to avoid an unbroken line of joints along any one joist. Thus, there will be three laths side by side carried right across the joist, then three jointed at the ends, though separated by a space as we have described, then three more unbroken, and so on. The loose end of a lath that has had a broken portion cut away should be secured to the joist with a galvanised iron lathing nail. These nails are sold specially for the purpose, and the amateur will have to provide himself with a quantity of them; for a small repair, galvanised clout nails form a good substitute.

When all loose pieces of plaster have been cleared away and the lathing has been restored and strengthened so that it will safely support the new stuff, the edges of the

hole and the laths should be thoroughly brushed, in order to remove all dust and loose fragments that otherwise might prevent the fresh plaster from gripping the old work; the hole is now ready to be plastered. If we were making a new ceiling or plastering the whole or an extensive portion of an old one, we should lay on the plaster in three layers or coats, but repairs on a small scale are usually carried out in two coats—"plaster and set"—the use of an intermediate coat, known as "float," being omitted as a separate operation.

Coarse Stuff.—Our first, and thicker, coat consists of "coarse stuff." Its basis is ordinary bricklayer's mortar, made by slacking quicklime with water, and adding sand, which operation will be found described in the article on MORTAR. For coarse stuff the mortar must be thoroughly mixed with clean and well-beaten cow hair, the latter serving to bind the whole together. The following proportions should be used:

Lime paste . . .	6 parts
Sand . . .	12 parts
Hair	1 part

The sand used should be perfectly clean and sharp and free from clay and other foreign matter; sea sand should be avoided. The cow hair should be well beaten out, so as to separate the matted hairs, or else soaked in water for two or three days before it is used. Mix the plaster thoroughly with water on the mortar-board, adding the hair gradually; the mixture should not be too moist, yet must be loose enough to bulge readily over the backs of the laths and cling to them fast.

The laths and the edges of the old work are now to be wetted by means of the brush dipped in clean, cold water; be careful not to make the laths too wet, however, as this is likely to make them warp.

Now take a supply of coarse stuff upon the hawk and with the trowel apply it to the laths and broken edges of the plaster, working it well into corners with the point of the tool and taking care that it "keys" well over the edges of the laths. This coat of coarse stuff must be brought forward evenly all over to about $\frac{3}{16}$ in. from the surface of the ceiling. Its evenness should be tested by applying the straight-edge across the hole in several

directions. Finally the plastic surface should be scored all over with intersecting lines about ¼ in. deep and 2 in. or less apart, according to the size of the repair, so as to provide a key for the finishing coat. This keying can be done with the edge of the trowel; on large jobs the professional plasterer uses a "scratcher," which consists merely of a few pieces of lath whittled to a point at one end and nailed to a cross-piece, or else transfixed by a single nail and opened out into the form of a narrow fan.

Finishing Coat.—The coarse stuff must now be allowed to set quite hard, and so should be left for about a couple of days. The repair is to be completed with a single setting coat of "gauged stuff," which is made in the following manner: Lime paste is thinned down with clean water until it is of a creamy consistency. It must then be allowed to stand for a while, until the suspended matter falls to the bottom. The surplus water is poured off, and the mixture is allowed to stand until it becomes stiff enough for working. Plaster of Paris should be added in the proportion of 1 part to 3 or 4 parts of lime; and the addition of a little size completes the "gauged stuff." The amateur must be warned that plaster of Paris and the majority of the plasters and cements of which it forms an ingredient have the property of hardening very rapidly; hence in executing a large repair only small quantities of the plaster should be mixed at a time.

The finishing plaster is laid quickly upon the hawk, and a quantity is transferred to the float and applied to the surface of the coarse stuff, which should previously have been wetted. The float is then moved over the surface in a series of curves. More plaster must be added gradually until the repair is perfectly level with the existing surface of the ceiling when tested all over with the straight-edge. It is very important to get it quite true and even, as a ceiling that is not level reflects the light unevenly, causing odd patches of shadow. The finishing touches to make the work quite smooth are made with the trowel, which must be perfectly clean and free from superfluous plaster.

Minor Repairs.—Small holes and cracks in ceilings that do not involve any damage to the laths can be completed in one coat, using Parian or Keene's cement, both of which will be found described in the article on Cement.

In all classes of repairs the smallest vestige of loose or crumbling plaster must be removed before the new stuff is applied. Large cracks should be raked out with the point of a trowel. If they contain dust, soot, cobwebs, etc., the old plaster must be well washed with a brush dipped in cold water, and then scraped quite clean with the trowel, before the new plaster is applied.

Cornice Repairs.—Damaged cornices and ceiling mouldings can be repaired to match existing work with Keene's cement. Cast work in relief should be modelled as rapidly as possible—owing to the quick-setting properties of the cement—with a spatula, spoon handle, or piece of wood, taking an undamaged part of the work as a model. The faithful reproduction of intricate detail should not be sought after so much as a good general resemblance to the model, especially in a high ceiling with a fair amount of ornament, for when the work is distempered or tinted to match the existing work only the general shape is likely to catch the eye.

A short section of straight moulding that has been damaged or quite broken away can be restored as follows: After the moulding has been made perfectly clean and free from dust and well moistened, the gap in the cornice should be built up with Keene's cement a little higher than the finished surface is to be. Then take a perfectly straight and smooth piece of wood or metal longer than the portion to be restored, so that its ends will rest upon the sound portions of the cornice on either side. Pass it slowly and evenly downwards over the freshly plastered work, so that it shapes it exactly after the pattern of the unbroken cornice and at the same time smoothes off the surplus plaster. Finally, smooth off the work with a clean trowel, taking care to form clear, sharp arrises. When hard, the work can be sized and distempered to match the existing work. Full instructions for this operation are contained in the article on DISTEMPERING.

DISTEMPERING CEILINGS AND WALLS.—Probably the quickest, easiest and cheapest method of decorating a plastered wall or ceiling is by the use of distemper. When properly carried out on a good surface, this yields an even matt coating with a minimum of trouble. Ordinary distemper, or colour wash, differs very little in its essentials from common whitewash, con-

sisting of whiting, water and size, with the addition of any colour desired. While suitable for ceilings, friezes and other remote surfaces, ordinary distemper is not to be recommended for covering walls, since it soon soils, and when dirty cannot be washed, so that the only satisfactory way of renovating the surface is by re-distempering. For this reason it is usual to employ instead an oil-bound sanitary water paint, which, having an oil basis, can be washed repeatedly with perfect safety. This patent preparation, of which there are many proprietary brands, is what the majority of householders refer to as "distemper." It is sold in either a powder or a jelly form, and when mixed to the right consistency with cold water, is ready for applying to the walls. Its cost is somewhat greater than the non-washable variety, and since the householder may care to decorate his ceilings with the latter, we will give instructions for preparing it.

Dead white distemper on a ceiling rarely looks pleasing, since it is apt to give a crude and glaring effect—more so, in fact, than white ceiling-paper. Far softer and more artistic is the effect of a shade of ivory or light cream, while the ceiling of a room that has neither picture-rail nor frieze looks well if tinted to tone with the walls—preferably in a lighter shade of the same colour.

How to Mix Distemper.—A good ceiling distemper can be made as follows. A quantity of best gilder's whiting, broken up small, is placed in a pail, covered with cold water and allowed to stand, after which the surplus water is poured off and the mass well mixed. Now take some best size, preferably in powder form, and dissolve it in warm water. Heat it over the stove while stirring, but do not bring it to the boil. The amount of water added should be sufficient to yield, with 1 lb. of dry size, 1 gallon of liquid size.

If a pure, cold distemper is required, a little ground-up ultramarine blue should now be added to the whiting.

Tinted washes may be prepared by the addition at this point of the following pigments:

For light grey *add* Lamp-black;
For French grey *add* Prussian blue and lake;
For blue *add* Prussian blue, cobalt or indigo;

For green *add* Prussian blue or indigo with yellow ochre or chrome yellow; or else *add* emerald green;

For buff *add* Yellow ochre with a trace of Venetian red;

For cream *add* Yellow ochre;

For fawn *add* Umber, lamp-black and Indian red in the proportions 4, 1, 1;

For stone *add* Yellow ochre with a little blue-black;

For pink *add* Rose-pink;

For lilac *add* Indigo and rose-pink;

For salmon *add* Venetian red and a little yellow ochre;

For terra-cotta *add* Burnt sienna.

It should be remembered that distemper dries somewhat lighter than it appears when liquid. It is as well to experiment until the desired shade is attained, but sufficient of the wash or distemper should be made at one time to complete the whole of the job, in order that difficulty may be avoided in colour-matching.

When, by allowing a little of the mixture to dry on a white surface, it is judged that the correct tint has been obtained, the hot size should be added gradually, a gallon or so being enough for every 6 lb. of dry whiting that was used (1 lb. of whiting should be provided for each 40 ft. of surface to be covered by one coat). The mixture must then be thoroughly stirred and freed from lumps and impurities by being strained through clean, fine sacking or coarse calico. It should not be applied before it is quite cold.

We will assume that the amateur is first going to tackle a ceiling; this must always be distempered before the walls, if the entire room is being decorated. The first thing to do is to clear the room completely of furniture and ornaments.

If the walls are not to be afterwards treated, they should be entirely covered up with large dustsheets (or newspapers) tacked close under the ceiling; if the frieze is to be included in the distempering, the dustsheets should be tacked to the top of the picture-rail. It is preferable to remove the carpet also, but if desired, it may be covered with a thick dustsheet over several layers of newspapers. It is practically impossible to distemper a ceiling properly from the top of a step-ladder, and a platform should be rigged up consisting of a wide plank supported on a pair of step-ladders or

trestles; since any work on a ceiling is a very fatiguing operation, the amateur should be within easy reach of the work, so as to avoid stretching up to it.

Preparing Ceiling.—First of all the ceiling must be washed down thoroughly. This is done with clean, cold water applied with a large, flat distemper brush, which should be drawn slowly to and fro over the ceiling, a fairly strong pressure being exerted. The brush should be rinsed out repeatedly and the water changed, if necessary. The final washing may be done with a large sponge. The washing should not be scamped, for it makes all the difference between failure and success in distempering; it should be continued until the final water is practically colourless.

The ceiling should then be left for a while to dry, when all cracks and imperfections must be raked out and filled with Keene's cement as has been already described in the article on CEILING REPAIRS. Large, irregular patches may be covered with a piece of fine lining-paper, which should be thinned down at the edges with a sharp knife; it will then be almost imperceptible when pasted in position. Finally, all roughness in the plaster must be rubbed down with fine glass-paper, until a smooth, even surface is obtained, at which stage the ceiling is ready for the coat of clearcole. Before being distempered, any ceiling—especially if very porous, a condition which will be detected readily in the washing—should receive a coat of "clearcole." This may consist of liquid size like that which we have already described, before it is added to the measured quantity of whiting. If the ceiling is very discoloured a little whiting may be incorporated in the clearcole, up to the proportion of 1 part of soaked whiting to 2 parts of hot size. The clearcole should then be well mixed and strained. It may be used while still hot, if desired, though a better "stopping" effect is obtained if it has been allowed to set to a thin jelly before applying.

The clearcole, when ready, should be applied with a large, flat distemper brush, and must be laid on quite freely and evenly, the brush-strokes being made equally in all directions. All the doors and windows of the room must be closed during the operations of clearcoling and distempering, in order to prevent currents of air from

unduly hastening the drying, but as soon as each of these operations has been completed, they must be thrown wide open so that the work may set as rapidly as possible. The clearcoled surface must be left for several hours to dry out thoroughly before the distempering is begun.

The amateur must please himself whether he makes up his own distemper in the way which has been described or whether he uses a proprietary brand of washable oil-bound distemper. For all but the cheapest quality of work, the superior virtues of washable distemper should not leave much room for choice. However, one often desires a cheap and pleasing colour-wash for an outhouse, scullery, w.c., or similar place, and in such a case a home-prepared distemper is convenient. A little colour in the medium avoids the "cheap" effect of ordinary white distemper.

Using Washable Distemper.—The directions of the individual makers should be strictly adhered to in preparing distemper for use. Usually all that is needed is the addition of clean, cold water until the distemper assumes the consistency of thick cream. In some cases the makers recommend the use of a special proprietary "petrifying liquid" instead, although this is not obligatory; size should not be added, as sufficient is already incorporated in the distemper. The distemper should be thoroughly beaten up before water is added, if it is of the jelly variety; and in any case it must be thoroughly mixed with the water by means of a wooden lath, and should be frequently stirred throughout the course of the work. Before being used, it must be strained through a cloth. Should it at any time get too thick, it must be thinned with a little cold water or the special thinner.

Distemper should be applied with short, rapid strokes of a well-charged brush in all directions. The brush, however, must not be too full, or splashing will result. The edge that is being worked on should never be allowed to get dry, and for this reason the plank and trestles upon which the worker is standing must be moved about smartly when necessary. In the case of a long, narrow ceiling, the distempering should be done in strips across the width. There must be no attempt at precise and formal brush-strokes, the chief essential being speed and an evenly-flowing surface. A painter's sash tool will be

found useful for working the distemper into corners and into the intricacies of mouldings.

Dealing with Stains and Marks.—Care must be taken that no patches are missed with the brush, for it will be impossible for the amateur to touch them up satisfactorily afterwards, all attempts to do so merely resulting in a conspicuous patch. In this case, the only practicable thing to do is to go all over the ceiling again when it has dried, this time with a somewhat thinner distemper. In any case, when walls or ceilings are very soiled or when the new distemper is of a contrasting colour to the old work, they will require at least two coats. The second should not be applied till the first has set hard. Bad stains, however, such as those resulting from persistent damp, will appear eventually through any number of coats of distemper, and therefore must be treated thoroughly first of all. Such a patch must be well scrubbed with a hot solution of soda and then well rinsed off in clear water. Then it should be treated with a coat of white knotting (which can be obtained at any oil and colour shop), or else with two coats of a preparation made by mixing white-lead in a paste-form with a little linseed oil, and then adding equal parts of turpentine and japanner's pale gold size, so as to bring the mixture to the consistency of ordinary paint. Common oil paint should not be used for touching up stains and patches previous to distempering, since it permits excessive condensation of moisture on the walls. Distemper can, however, be applied over old paint, even with a gloss, if the surface is first cut down by scouring it with pumice-stone and water.

If walls or paintwork that are not to be redecorated become accidentally splashed while a ceiling is being distempered, the splashes should be removed at once with a wetted rag. Preferably another person should attend to this so that the distempering may not be interrupted. Rubbing with a piece of stiff dough will be found to remove splashes from wall-paper. Splashes that have been overlooked and allowed to dry can, if not too large, be successfully removed with a sharp, clean knife; this method should always be adopted whenever distemper splashes from walls fall on a distempered ceiling.

Stippling Walls.—A very beautiful matt-surface can be produced on a distempered wall by stippling, which

consists of patting the surface while wet with a special brush provided with perfectly level bristles of hoghair. If the amateur is likely to do much distempering, he would do well to invest in such a brush. For small jobs, however, a clean flannel cloth may be used with good effect. It should be large enough to fit the hand comfortably, and must be evenly folded so as to present a smooth surface; it should be wrung out of water before use. Two persons are necessary for stippling—one to lay on the distemper, another to follow with the stippler, patting the freshly wet surface with firm but gentle and even strokes. When it becomes too full of distemper, the brush or cloth must be lightly dipped in cold water and shaken or wrung out.

After use, both the distempering and the stippling brush must be thoroughly washed out in clean, warm water and hung up to dry. A brush can quickly be ruined by being allowed to stand upon its bristles in a bucket or elsewhere for any length of time.

FLOORS, STAINING AND PAINTING.—In the case of deal floors it is always a good policy to decide on a reasonably dark colour for a stained surface, because the grain is not usually attractive enough to warrant light finishes. Where the floor has not been finished in any way before, it is common to find much unevenness, nail holes, etc., also cracks between the boards. The cracks should be filled up with stout string well driven down below the floor surface to allow of stopping being inserted on top. If the string can be soaked in old varnish so much the better. Care must be taken to leave unstopped traps of any kind, as these may at some time have to be removed. Such traps should be taken up, prepared and finished separately, and relaid when dry, taking care to apply the same coats of material as the floor receives. Should the trap be broken or a bad fit, any faults can be made good by a new board or small slips of wood fixed to it.

When all cracks are filled with string proceed to punch all the nails below the floor surface with a nail punch of about the same size as the nail heads. Do not attempt to do this with the hammer alone, because you will certainly bruise the boards and will not drive the nails deep enough. Each head should be about $\frac{1}{8}$ in. below the surface to allow for stopping. The boards are sometimes

found to be at different levels and in this case the higher one should be planed down with a good sharp smoothing plane before the stopping is commenced. Now make sure the floor is quite clean; remove old paint spots by scraping, and remember that old stains of any kind will show through the polished finishes.

Filling.—The best filling for deal can be made cheaply by boiling some medium-strength glue and mixing some deal sawdust in about equal proportions by bulk. This material can be put into the holes and cracks and compressed by means of a stout putty knife or an old table knife; take care not to miss any faults or holes. Fill up the holes and allow some hours for the stopping to dry—in a warm room it will dry quicker. When by testing it is found to be hard, the whole floor should be rubbed down with a medium-grade sandpaper, such as No. 2, until smooth. The movements should be with the grain and not across it. We have now reached the stage of a flat, smooth, bare floor and can proceed to stain.

Staining.—The easiest stain to make and apply for oak finishes of all shades can be obtained by dissolving in either boiling water or hot size some Vandyke crystals, which may be bought at any oilshop; light or dark shades are obtainable by adding to or reducing the quantity of water or size.

To this preparation can be added experimentally a little rose-pink, venetian red, red ochre, or any other of the dry powders soluble in water. The variety of shades thus obtainable is almost unlimited. As far as possible only one colour should be added, as many shades have a tendency to neutralise each other when mixed together. For a good medium shade use about 2 oz. of crystals to ½ gallon of water or size, as above. This is enough to cover floors of approximately 100 sq. ft. in area.

Do not be surprised if when the stain is dry it appears very light, since the varnish or polish will not only darken but also enrich the colour when applied. A test of the result is always advisable on a piece of wood (deal) before commencing on the floor proper. The stain if thick may be put on to a gas ring and warmed before application, and if applied when warm will penetrate the boards more easily. Care must be taken to ensure that the stain is free from lumps and the floor free from dust or dirt of any

kind; cleanliness is essential, and soft carpet slippers should be worn whilst traversing the room. Do not walk on any part of the floor until the various applications are quite dry. A glossy finish can be obtained with glaze, varnish, or french polish.

Varnishing.—The error is often made of applying one thick coat. This takes some weeks to dry really hard and should be avoided. Apply instead two very thin coats and spend plenty of time in brushing it over the surface; allow about 24 hours between each coat. This method will give a surface both attractive and really durable. The spirit varnishes are not advised as the surface they produce chips so easily under the tread.

French polishing is a more tedious job, although the drying process is much quicker. Much practice is necessary to acquire the knack of polishing, but a modified method known as glazing can be used instead. It is particularly useful on large surfaces like those we are now considering. Details of its use will be found in another article.

When black or a very dark tint is the colour required on a floor the same process of stopping and preparation should be followed, but a coat of good strong size should be applied to the bare floor before staining. This will take about 6 hours to dry, when the stain can be applied. Obtain a 1-lb. or 2-lb. tin of drop black in oil and dilute this with a sufficient quantity of the best quality turpentine. This stain must be clean and free from lumps, and of a thinnish consistency. Avoid making the colour too light by over-dilution with turpentine. Apply the prepared stain on top of the already sized flooring. It can be made harder and more durable if a little good varnish is added—say, about 1 tablespoonful to 1 pint of stain.

At least 12 hours should be allowed for drying, when varnish or polish can be applied in the manner stated above.

It will be found that where furniture polish is in general use in the house a final application of this will often impart an extremely good finish as well as preserve the body of the work from chipping. (*See* French Polishing.)

Parquet Floors.—These are nearly always made from hard woods, and it is the varied appearance of the grain that gives such fine and pleasing effects. The finishing

of these woods is less a polish than a soaking of the grain in order to show off the colours already contained in them: in fact, many of them are merely oiled with best linseed oil and the surplus taken off by means of a cloth. Continual dusting imparts the semi-dull finish so distinctive of parquet floors.

Parquet floors may become dirty and dull in time, when they will require to be cleaned. If properly treated such a floor will look as good as new again. Obtain a good quantity of steel "wool" of a somewhat heavier type than that used for cleaning saucepans in the kitchen. Taking a fair handful of this material, commence in one corner of the room and rub the floor surface until all the dirt is removed and the seemingly bare wood appears. Be careful not to rub the painted skirting, as the wool will soon take off the paint. When the whole floor has been treated in this manner, sweep off all the shavings and dust; if any dark patches have been left, these must be treated again until all the floor appears of the same colour. By this rubbing down we have removed that portion of the oil which had dried on the surface, and also the dirt and dust which had been ground into it. Careful examination will probably bring to notice a few pin-holes; these need stopping with warm beeswax. Each block should have been fixed down with fine pins when originally laid, and some of these holes may have lost their stopping. With a clean soft cloth which has been damped with linseed oil apply either white french polish or the ordinary brown quality to the whole surface by well rubbing in. Leave for a day, and then wipe off all the surplus oil with a clean cloth. The floor should now present an appearance like new, and can be polished regularly in the usual manner, using any good furniture polish. All rubbing down or cleaning should be done by working the same way as the grain, or tearing of the grain may result. Additional coats of oil and polish may be applied if necessary.

Stone Floors.—These are subject to stains, and great difficulty in cleaning out grease spots and oil is always experienced. Petrol in some cases will remove these two, by the use of care and patience; whilst anything more deep-seated will usually submit to the use of common spirits of salts. The utmost care should be used in

cleaning with petrol. Shut any communicating doors and open those leading outdoors. Choose a time for the job when no fires or stoves or cooking appliances are alight. Petrol vapour will travel many yards in an air current, and may become ignited even by a spark. Apply the spirit to the stain in small quantity and remove the rest of the petrol somewhere out of harm's way.

Spirits of salts is a corrosive and poisonous acid—a dilute form of hydrochloric acid — and care must be taken to avoid splashing the hands or clothing. It will usually be found advisable to deal with the stains first, and then to clean the whole floor again. A rather objectionable smell will be noticed while the acid is doing its work, but this cannot be avoided. The acid should not be left on the floor longer than is necessary to take out the stains, and at this stage should be carefully washed off again with plenty of clean water. All the acid must be removed. The soft or rough tiled floors may also be cleaned in this way, but for glazed tiles the acid must first be weakened by adding about 2 parts water to 1 of acid. If a stronger liquid is used the surface may be irreparably damaged.

It is not generally known that stone floors can be made to look attractive by oiling or polishing. Ordinary linseed oil applied with a cloth will impart a rich but slightly darker shade to most kinds of stone floors. This surface can later be polished with french or furniture polish and quite a nice gloss obtained.

Many other kinds of flooring surfaces are used in modern houses, the object as a rule being durability. They are usually to be cleaned by friction with some form of abrasive, such as steel wool or glass-paper, rather than by the use of detergent liquids. Cork laid in paste or matrix form, or in squares or tiles, is becoming popular owing to its sound-insulating properties and pleasing appearance either bare or polished. It can be cleaned very well with glass-paper, which is used on a block of wood or a cork pad about 4½ in. by 3 in. by 1½ in. to ensure a level and uniform surface. Cork linoleum also can be cleaned by this process, and may afterwards be polished with a good furniture cream.

Painted Floors.—These can be made very attractive, but, generally speaking, do not prove economical unless

used only for surrounds of carpets or linoleum. Once a painted surface becomes chipped by the feet or worn by movements of furniture the whole of the paint leaves that part of the wood and shows an unsightly patch which is difficult to obliterate in a surface of solid colour. In addition to this, a painted surface that is not absolutely flat and even looks a very poor job; whereas a stained and polished surface can tolerate a certain amount of visible grain and uneven texture which, far from being a blemish, may even add to the appearance.

Linoleum often bears the blame for wearing out when the fault lies with the floor underneath or the person that laid the lino. Any projection of nails or the floorboards raises the linoleum in a bump which, continually catching the foot, is soon worn into a hole. All inequalities of surface should therefore be dealt with in a suitable manner. Nails should be punched in and the inequality of surface caused by a projecting board levelled down by a layer of old newspaper placed in the low portion beneath the floor covering. Similar methods are necessary with carpets, though here an under-felt can first be laid. A linoleum or carpet given this care will last much longer than one laid directly on an old and defective floor.

FROST, PRECAUTIONS AGAINST.—The householder who desires to minimise the effects of a severe frost or spell of cold weather upon his water and sanitary services, must take the job in hand in good time, during autumn, before the colder weather sets in. The vulnerable points are those where any pipes run near the outer walls of the building. Outside w.c.'s are often a source of trouble owing to the lack of protection afforded to the pipes. An old-fashioned way to deal with the trouble is to wrap haybands about the pipe which serves the flushing cistern. Thick felt in strips is a tidier insulating material, applied like a spiral bandage around the pipe, or tacked against the latter where it comes in through the wall.

In the attic the rising main is to be covered with felt wherever it is exposed; the cistern there from which the bath cold supply and any indoor w.c.'s are served, ought to have a wooden cover and be further protected by several thicknesses of sacking laid on top. This cistern usually feeds the tank for the hot-water supply, and the

pipe from cistern going to the latter should be similarly covered with a lagging of felt. The main service pipe can usually be protected from freezing, except in the severest weather; but the cold-water cistern in the roof, with the pipes leading from it, are specially liable to cause trouble. Since, as we have said, the essential services to w.c.'s and hot-water tank often come from this source, a frozen cistern is a great annoyance.

There is usually a stop-cock outside the house on the main—generally in the forecourt—and the supply can be shut off here at night during cold weather or when a frost is threatened. If the pipe is thereafter emptied at the nearest and lowest tap on the rising main, this will be prevented from freezing. Any w.c.'s served from the main can be flushed last thing at night and their cisterns thus emptied. Then, when the main supply is turned on the next morning, the service will be again available. If the flushing cisterns are not emptied they are very likely to freeze during a cold night, and thus be put out of service.

Frozen W.C.'s.—In dealing with a frozen w.c. cistern, the cover is lifted up, after undoing the two screws that should hold it fast at the lugs, and hot water from a kettle is poured over the nozzle and ball of the valve. If the ball is merely trapped by ice on the surface, the task of freeing it is easier. The valve itself may be held fast by ice, which the hot water may remove. If the water in the pipe to the cistern is itself frozen, our efforts will be unsuccessful until we bring heat to bear—by placing a lighted oil stove in the w.c., and closing the door. It can be realised that prevention—by emptying the cistern and the pipes—is a good deal easier than cure.

Indoor water closets may be put out of action in very cold weather by freezing of the water in the trap by which they are sealed off from the soil pipe. The only way to prevent this is by keeping the house warm—especially at night—and by the use of some local heating device. The latter may be the oil stove above referred to; another method is to leave an electric light burning in the apartment, the door being closed. If the house is well warmed, however, it is better to open the w.c. door.

Cold-water Cistern.—A cistern in the roof, and its pipes, may be prevented from freezing if the trap door is

left partly open and some source of heat—an oil lamp or an electric heater—is stood on the floor beneath the trap. Oil lamps, as we remark elsewhere, are fickle and may be a source of danger, and it is unwise to leave them burning for long unattended. The best means of guarding against most or all of the troubles occasioned by frost is the careful stoking and regulation of the boiler or the range that provides the hot-water supply for the house. Unless, in fact, we look to this, the boiler itself is likely to prove a source of trouble or even danger.

Hot-water System.—Keep a good, steady fire day and night during frosty weather, and bank up the furnace at night, so that although there is a good body of fire left, it "keeps in" till the morning. In frosty weather the fire may "draw" more fiercely, so that unless damped down with slack or small coal it may not last the night through. Leave open the kitchen door, the bathroom door and also that of the airing closet, if any, to allow the heat to circulate in the house during the night. If the main stop-cock is to be shut, make sure that the cistern in the roof is functioning, and that there is an uninterrupted supply of cold water to the hot-water system. Refrain from drawing hot water until the main supply is again turned on, and see that "hot" taps are firmly shut.

If in spite of these precautions the pipes of the hot-water system become blocked—for instance, by the freezing of water in the cold cistern in the roof—we must exercise caution. Probably the hot-water system will be so arranged that it is impossible to empty the "hot" cistern or the boiler itself, for until and unless cold water runs in at its inlet, no water can be drawn from the "hot" taps. Danger, however, may arise through the system being sealed by ice in some pipe or other, and through the steam thus being imprisoned. Ordinarily, steam finds an exit through a vent pipe that goes up through the roof or ends above the cold-water tank in the attic. Water-heating systems differ in detail, some working at quite a low pressure and others at a higher one.

When the "hot" taps cease to deliver water it is best to shut them tight and refrain for a while from attempting to draw any water from them. Let the boiler fire down but do not extinguish it or allow it to go out.

Probably, after an hour or so, on again testing the taps, a trickle will be observed, and later a bigger flow. Listen if the ball-cock in the roof cistern is functioning; if it is idle, and cannot be put again into action, we are limited to the water that remains in this cistern and must not draw much—if any—hot water. Rather should we use the furnace and the piping as warming agents to try and effect a complete thaw.

The householder, when faced with any irregularity in the functioning of the hot-water cistern, must impress upon all in the house that his instructions are rigidly to be adhered to. One meets sometimes with ignorant or venturesome people who try to thaw a frozen hot-water system by making up a big fire in the boiler furnace! If, despite our nursing of the boiler, the water does not soon begin to run, the fire in the furnace or range must be allowed to go out and not be lighted again until a thaw is evident.

Burst Pipes.—When pipes freeze, they should be examined for bursts, which until the succeeding thaw might be overlooked. Besides actual bursts, any swellings of the pipes should be sought for, as they are a potential source of trouble that should be righted at the first opportunity. Lead pipes, of course, are referred to here, but the iron pipes of the hot-water system also may be burst by the expansion of water when freezing—it increases in bulk about 10%. Iron pipes may show a lengthwise split that is hardly discernible until a thaw later permits water first to ooze and later to flow out of it. Often the first and only sign of a burst is a wet patch appearing on the ceiling.

When a burst is located, the supply of water to the pipe in question is to be shut off by operating the nearest effective stop-cock. There may be isolating cocks at the cold-water tank which enable bath and w.c. supply —or the service to the hot-water system, as the case may be—to be shut off completely. In such a case the damaged pipe could be cut off from the rest of the system and damage by water prevented to some extent. The damaged pipe itself must be attended to by a plumber, who should be warned in good time.

It is very wise for a householder to take stock of his piping and plumbing when first he takes possession of a

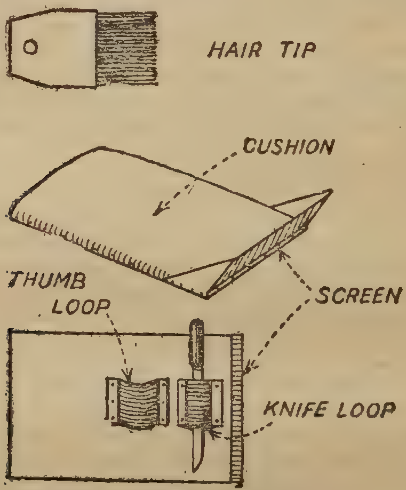
house, either as a tenant or an owner. With a knowledge of the lay of the pipes and the taps that control them, he will be able to deal with any defects in a prompt and ready manner. If there is not already an indoor stop-cock on the rising main he should consider the question of having one fixed; it is a convenience well worth the trifling cost, for in emergency the supply can be shut off from all parts of the house by simply turning the tap. The usual stop-cock outside, on the contrary, needs the use of a long-handled key; the key may be mislaid—often one is not available—and in any case it may be a difficult job in frosty or snowy weather to open the trap in the pavement, insert the key, and operate the stop-cock. Anyone can use the indoor tap without difficulty.

GILDING.—True gilding is the applying of a very thin leaf of gold or some substitute on wood or other substances to give them an artistic appearance. It is done by a variety of methods, with the use of vehicles or mediums adapted to each. The simplest and probably the easiest method is that of applying gold leaf by means of gilder's size. The gold size can be obtained at most good paint stores, and the gold leaf in books from artists' sundriesmen.

The tools necessary are a pad, a knife, and a tip. The pad can be made of ½-in. wood and a few layers of soft cloth covered by a single piece of smooth chamois or wash leather tightly stretched and tacked to the edge of the wood over the cloth. On the back is to be fixed a small leather loop for the thumb. The finished cushion should be about 8 in. by 6 in. and should have at one end, a shield of stiff paper or cardboard, to prevent the leaf from being blown away, when the pad is used as a surface on which to cut the gold to size before application. The knife should have a long flexible blade, not too sharp. It must be kept quite clean and bright. The brush or "tip"—usually of camel hair—is used for taking up the gold from the pad when cut to the size of the section to be gilded, and for laying in place on the work. Some clean cotton-wool and a large camel-hair pencil are needed also.

Having carefully applied a coat of the gold size to the work, it must be left until the time when, on dabbing

the finger on it, the finger slightly sticks to, but does not remove the gold size from the work. This may be twelve hours or longer. When ready to lay the gold, shake out a leaf on to the pad, take the knife and gently cut a piece the size required. Should the work be large enough to take a full leaf, no cutting is needed, of course. Take up the tip and touch it to the forehead, from which it will thus acquire a little grease. Pick up the leaf by



GILDER'S KNIFE, PAD AND TIP

gently touching it with the tip and carefully place it on the work in the proper position, so that no alterations are afterwards necessary. With practice good and invisible joints can be made, but any error should be rather to overlap the sections slightly. Gently press the leaf on the work with the cotton-wool pad.

Proceed in this manner until, say, 3 leaves have been attached; then with the camel-hair pencil remove the surplus gold by gently brushing off. Care must be taken to prevent the gold fragments becoming stuck to the other sections of work not yet completed; and in most cases it is wise to commence at the bottom and work

upwards. The whole article should be finished at one go. Any draught will make the work more difficult, for the leaf is extremely thin and is fluttered by the slightest air current. Any small parts which may have been missed with the first covering should be filled up by lifting and applying suitable portions of leaf with the camel-hair brush. Judgment in estimating sizes will save a great deal of gold, as the surplus is wasted. The gilder saves his wipers and the gold is recovered from them, but this is not practicable for amateur work.

A better result is obtained by first applying a coat of flat white paint and the gold size on top when the paint is quite dry and hard. This is more convenient in that it enables one to observe any parts on which the gold size may be wanting. The size should be evenly applied and not allowed to run or to collect in corners. In repairing a patch in gold leaf, the size should be carefully applied to the bare work only, and very sparingly, for any size on the surrounding gold will impose another thickness of leaf that will show up. In patching, make sure also that leaf of the same colour as the original is used. To the novice there may appear little difference, but the accustomed eye will note the variation.

Gold paints.—These are never so satisfactory as gold leaf, since the finish is always granular and therefore dull, though much of this can be remedied by afterwards varnishing with good spirit varnish. Metallic paints are applied in the ordinary way but frequently stirring is necessary, as they soon settle.

GLASS AND GLAZING.—A broken window pane is easily replaced. First the broken fragments are carefully to be removed and placed where they can do no harm. Then the old putty must be hacked out and the rebate cleaned up ready for the new pane. The glazier uses a special hacking knife with a thick blade; this is pressed or tapped all round the rebate to remove the hardened putty. The handyman can use any short stout knife for the purpose and the rebate can be cleaned out with a blunt chisel, taking care, however, not to injure the woodwork. Sometimes, in addition to the putty and concealed by it, brads are knocked in to hold the glass. These must be watched for. Obtain a new piece of glass slightly smaller than the dimensions of the rebated part

of the sash of casement. Measure all four sides of the opening, in case it may not be exactly square.

In addition to the glass some putty must be purchased; it will probably be of the proper consistency for use, but if too hard it can be worked up with a very little linseed oil until soft enough. Roll out some of the putty and lay it in the rebate all round so that the glass can bed against it. The layer must be even in thickness. Place the glass in the rebate and press it gently home against the putty. Next take a roll of putty and fill up the rebate behind the glass, making sure that the corners get properly filled in, between the edge of glass and the frame of window.

The putty is smoothed off to an even bevel with a putty knife—an old table knife will do as a makeshift, but the proper tool is much better—which has an angular, pointed blade and can be worked into the corners. The line of the putty should come even with that of the rebate, and not project farther on to the glass, or an ugly appearance will be presented from the inside of the pane. Two or three days later the putty can be painted to match the window frame.

When making up a glazed frame the woodwork of the rebate must be painted before the glass is put in, since putty will not properly adhere to bare wood. In dealing with a repair where brads are found, the old putty must be cut away gingerly and the brads pulled out with pincers as soon as they are exposed and free of the putty. Brads are used in securing large panes.

Cutting Glass.—A glazier's diamond is the most satisfactory tool for cutting glass, but it is somewhat expensive and is easily damaged by inexpert use. A wheel cutter can be bought for much less and, if a good quality one, will answer the handyman's requirements for occasional jobs. Prepare a flat and level surface—a table top, for example—by laying upon it several thicknesses of newspaper. A straight-edge and a T-square are needed for cutting rectangular shapes. Lay the straight-edge upon the sheet of glass so that the width to be cut projects beyond it, assuming the sheet already to have a straight, square edge; note that the wheel or the diamond in the cutter is set-in a little from the face of the metal mount, and this thickness must be

added to that measured off for the dimension of the pane—the glass projecting beyond the straight-edge for another $\frac{1}{16}$ in. or $\frac{3}{32}$ in., perhaps. Press firmly upon the cutter, holding it somewhat in the manner of a pencil and sloping slightly backwards. Draw the cutter along from the front of the glass towards the back, close against the straight-edge. The glass should now part away easily along the cut line if the sheet is rested face down upon the straight-edge and pressed lightly downwards.

A cut at right angles is made by laying the T-piece of the square against the cut edge at the proper distance and bringing the glass cutter against the blade, which is used as a guide instead of the straight-edge. If the piece to be cut is not too long a carpenter's try-square can be used instead of a T-square. Curved and other shapes that do not admit of the above method are cut from a template of stout cardboard or other suitable material laid on the glass.

Varieties of Glass.—Ordinary window glass is of the substance denominated as 21-oz.—this means that a square foot of it weighs nominally 21-oz. For garden frames, greenhouses and similar purposes where the optical properties of the glass are not the first consideration a cheaper grade known as horticultural glass is used. It is sold in case-lots of a certain length and width; or the width might be constant and the length vary. In glazing lights the latter point does not matter a great deal, since the glass is lapped slightly in its length. A case containing 200 sq. ft. of 21-oz. horticultural glass costs in the neighbourhood of thirty shillings, foreign glass being cheaper than British-made glass. The gardening journals contain advertisements of these goods.

Other kinds of glass that may interest the amateur are rolled plate, $\frac{1}{4}$ in. thick, and wired glass. The latter is used for overhead work such as the glass roof of a verandah, and is formed with a wire netting embedded in its thickness. Thus the glass, if cracked, is supported by the netting. Wired glass has certain fire-resisting qualities and is therefore used in doors in commercial buildings. Tinted glass, and glass rolled in various patterns, are used for entrance doors and others. These varieties cost from 10d. to 1s. 2d. per sq. ft.

The repair of leaded lights is treated in a separate article under that title.

GRAINING AND MARBLING is the imitation of hard-woods on the common species by means of paint. First of all the lighter parts of the grain to be copied are applied to the well-prepared surface as solid paint, great care being taken to match the colour. This "ground," as it is called, should be finished almost flat or dull and must be dry and hard before graining.

Oak or Mahogany.—These are the most popular "grains." For the former the usual mixtures comprise raw sienna, burnt umber, white lead, and venetian red. These should be finely ground on a piece of glass and then mixed in correct proportions to obtain the colour desired—with equal proportions of linseed oil and turpentine. Patent dryers are to be added, and 1 teaspoonful to about 1 pint of colour should be enough. Apply this colour with a large brush thinly but evenly. If too thickly applied the work will look dirty when finished. With a dry, stiff dusting brush dab the work until the stain looks evenly distributed.

A pattern is essential to the inexperienced, and this should be copied as nearly as possible. Several pieces of oak in this case should be copied, using separate ones for each section of the work. One or two combs are then used to get the fine grain; this is generally found throughout, so that the whole surface must be gone over with the comb. Slightly wider combing is used on one side of each section. The last comb must be very fine and if slightly waved to and fro as the ground is covered the effect should be a good one. It is sometimes useful to cover the wider combs with very thin rag. The "figure" or veining is next to be wiped out with rag and the thumbnail, or with a similarly shaped piece of cork or wood. After several wipes the rag must be moved a little so as to present a clean spot. Good appearance can only be obtained after practice and careful study. No written instructions can supplant this. Practise on a surface that does not matter. When dry either ordinary or flat varnish can be applied to taste.

For mahogany grain the stains to be used are orange chrome, venetian red, and white lead mixed in correct

proportions. Vermilion, raw sienna, and burnt sienna are employed to modify the shades.

Satinwood.—White lead and yellow ochre are used here. With this the ground must be very light, since the varnish tends to darken when applied.

Marbling.—This process is carried out in the same order as with graining. The finest colours must be used, so that each succeeding coat may be applied thinly and yet be full in colour and opaque. It will then leave as flat a surface as possible for the final varnishing. The term "flat," we may remind the reader, here means the reverse of glossy.

The tube pigments are the best for this work, as they are very finely ground, very strong in colour and will give the opaque appearance that is aimed at. The best oil and turpentine is to be used, and absolute cleanliness is essential. If each coat be allowed to dry really hard, then mistakes can be at once obliterated by quickly taking off the defect with a clean soft rag damped with turpentine, after which another effort can be made. After varnishing no correction is possible.

The various effects are got by the use of different brushes, and by working with a rag-covered finger-tip or thumb. A granite effect can be got by dabbing with a sponge. Only the simplest effects are possible until some proficiency has been acquired by patient experiment and practice. The skilled craftsman has many dodges of his own and uses special methods he has worked out for himself. Colour is applied, for example, with the tip of a feather, and veins are simulated by deft work with a fine sable brush.

The combs for graining are sold by some tool merchants and paint stores. Here, too, the amateur can get transfers for producing a grained effect in an easy and simple manner.

LEADED LIGHTS, REPAIRING.—When a pane of a leaded light becomes broken, the repair looks something of a problem, though to the man who can use a soldering iron it is not too difficult a task. Remove the window and lay it on a bench or on the table. The edge or flange of the lead strip—the latter is known as a calm—is to be prised up gently with a putty knife or a blunt chisel and the broken pieces of glass taken out.

If possible, take careful measurements from these to ascertain the size of the glass for replacement; failing this, measure another pane and allow for the parting strip or "heart" of the calm. The glass must not be too tight a fit or it will be impossible to insert it. In the case of a lozenge-shaped pane, a cardboard template of the proper size should be prepared for the glazier to use as a pattern for new pane.

Clean out of the groove any old cement that may be therein.

Having procured a new pane of glass, try whether by lifting up the flange on three sides it will be possible to insert it. Do not actually push it into place, however. Probably a cut will be needed in the flange on two sides, close to the corners, before the glass can be pushed in. Some white lead will be needed as a cement; it is later to be applied to the flanges of the lead around the opening to fill up the space between the flange and the glass and make a weather-tight joint.

Open out the flanges as much as possible without deforming the calm, and carefully cut flanges if necessary. Lay glass in place and press down flanges again. If the flange had to be cut it must be re-soldered; if, however, it was merely prised up, we can proceed to work in the white lead beneath it all round at back and front, when the job will be finished. Should soldering be needed, a fair-sized copper bit with a stubby end is the best, or a hatchet-shaped bit. It is unlikely that the amateur, however, will have any but the ordinary tool, and the best must be made of that. Some bits are adjustable and can be turned at right angles to the handle on unscrewing a nut. If one of this sort is available, turn the bit into the hatchet shape and tighten nut again. A good-sized electric soldering iron is suitable, but one of the little ones usually sold for amateur use may not hold sufficient heat.

The flux for lead is tallow—a tallow candle is handy for our task—or resin. One of the proprietary fluxes can be used if preferred, but take care that it is suitable for lead. Heat up the soldering iron, have flux and a stick of solder ready, and the joint coated with a smear of tallow. Place the iron on the flange that was cut, with the stick of solder in contact. If hot enough, the

iron will cause the solder to flow and it will adhere wherever the flux was put. If the iron is not hot enough, a satisfactory job is impossible.

Re-heat the copper bit and proceed to solder any other flange that was cut. Of course, the hot iron must be kept away from the glass, and be brought in contact only with the surface of the lead calm. If the tool is a pointed one, it will be necessary to bring the side against the lead, in order to get more heating surface, so that it is not too easy to avoid contact with the panes. Patience and some deftness are needed, but a sound job can be done and some considerable expense avoided by using the necessary care. Work cement under the flanges after soldering, and wipe off as much of the surplus as possible.

PAINTING AND ENAMELLING.—The enamelling of the woodwork of a room differs from ordinary painting for a number of reasons. The high gloss imparted to the work by the enamel demands a great deal more preparation to the ground-work than is strictly necessary for painting. When the enamel is applied, every mark such as unlevel planes, proud knots, stringy surfaces, bad mitre joints in mouldings, chips in the old paint, and badly filled holes are much more obvious to the eye owing to the amount of light reflected from very glossy surfaces.

The undercoatings must be of a special nature and consistency to dry absolutely flat and hard, and must not contain more oils than is vitally necessary to their permanency. Since enamel contains relatively very little colouring matter, the undercoats must provide the body of colour required for finishing, before the enamel is applied, or the finish will always appear unequal in colour and look shady. The paint should be strained through very fine gauze immediately before applying each coat, and an old piece of silk stocking is one of the finest materials for this purpose. All brushes ought to be rinsed in clean turpentine before using, and the paint stirred occasionally during use to ensure a uniform consistency throughout the period of application. The thinner the paint is used (and in consequence the greater the number of coats applied), the better will be the result in every way. Owing to what is called ropiness, thick paint will require more rubbing down than the thinner

consistency. The bristles always leave a slightly ridged finish on the paint, and the thicker the paint the higher the ridges.

In considering the painting or enamelling of a room,

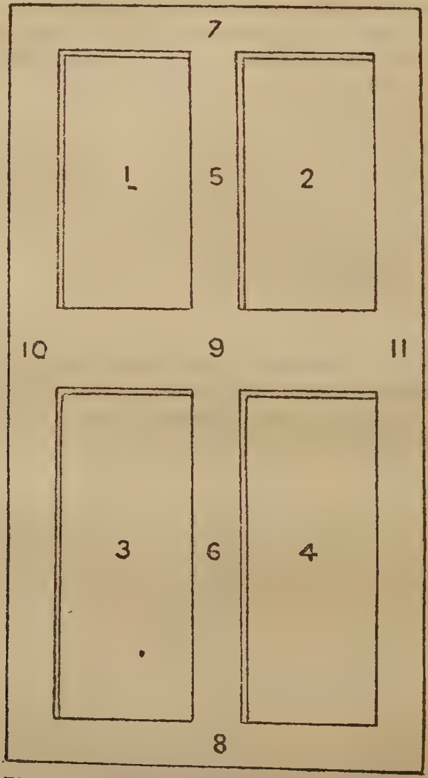


Fig. 1.—CORRECT ORDER FOR PAINTING A FOUR-PANELLED DOOR

one should always if possible arrange to change also the wallpaper, for good results cannot be obtained where the wall adjoins the paintwork, except with very great care. After the walls have been stripped and the holes and

cracks stopped up with good plaster and prepared for paperhanging, the paintwork should be well washed down and pumice-stoned as flat as possible. If the work has been varnished or enamelled before, the pumice stone should be used to remove as much of the gloss as possible. During the washing all soap or soda used must be well washed and leathered off, particularly in the crevices found on most woodwork.

The work being quite dry and clean, all holes should be stopped with a mixture of white lead and ordinary whitening ground together to a very stiff paste. The stopping is applied with a stout knife and forced into the holes, care being taken to leave a flat surface so that none of the stopping remains on the surface around the hole. For coloured enamelling a little of the undercoating should be added to the stopping.

White-lead flat undercoating of good quality having been obtained, add only sufficient turpentine to get the required consistency. With clean brushes (one 3-in. and one 1-in. brush will be found convenient for most work), the necessary coats may now be applied. To obtain an even surface it is important to brush the paint in all directions, commencing with a scrubbing pressure and slowly working up to very light strokes with the brush, and finishing with the very light "laying off" from the extremity of any section to its opposite end or side. The work should always be laid off in the direction of the grain.

Fig. 1 shows the correct order of painting an ordinary four-panel door, and the sections are numbered in the order of application. Each part must be laid off and finished before starting another section, and any later interference should be avoided. Paint, although taking hours to dry, only takes a few minutes to set, so that once a section of work has been started the job should be continued until the whole has been finished in that particular coat.

Each coat when dry and hard must be very gently rubbed down with fairly fine glasspaper, taking care not to remove the paint from the sharp edges, and the coats must continue until the desired depth of colour is obtained.

When ready for enamelling—the application of the

glossy coat—the surface should look quite "dead"; a dry, clean cloth gently passed over the surface will take away what little oil may be present.

Enamelling.—A good-quality enamel should be purchased, and a fair price is somewhere in the region of 25/- per gallon. For the ordinary-sized room consisting of 1 door, 2 windows, fireplace and about 45 ft. of 6-in. or 8-in. skirting, one pint of enamel will be found sufficient. Start by doing the most important work, as the enamel and brushes are then quite clean. Commence with the door, then deal with fireplace and window, and end up with the skirting, since on this part the worker is most likely to encounter any dust that is present in the room. The good enamels as sold are ready for use, and any thinning out must be avoided if possible. If necessary a very little turpentine may be well stirred into the enamel.

A brush somewhat shorter in the bristle should be used if the enamel proves difficult of application. All enamels have a tendency to run, and a strong and very patient spreading should be carried to persistence, because a door which takes ½ hour to paint will take even the expert 1 hour to enamel. The object must be to make sure of covering all the surface with as little enamel as possible. The running does not take place for some minutes after application, when it is very difficult to remedy in an effective manner.

Windows.—Fig. 2 shows how to paint the ordinary counter-balanced window. First pull down the top sash A and raise the bottom sash B to its full extent. This will disclose bar A1 and some inches of bars A2 and A3, which should be painted with A1. Next pull down B and paint the top part of A. Paint the top part of the runners of both windows and also sides of runners. After these parts have been dealt with, any procedure may be used to finish the window.

Varnishing Front Door.—The entrance door of a house is usually varnished rather than enamelled, but the same method of preparation can be used, and similar materials employed in any desired colour. If the old paint is at all blistered it must be removed by a liquid paint-remover, or by burning off, right down to the bare wood. A coat of white flat paint with about 5% of red

lead well mixed should be applied before the undercoating. The burning off is done with a blow-lamp. The paint is well warmed by the flame and removed with a knife suitable to the surface.

The varnish to be used is almost transparent, and will not remedy any faults or make up for deficiency in the colour supplied by the undercoating.

The paint should not be applied during very hot sunshine if the sun's rays fall directly on the door, and the same applies to the varnishing. A much better and

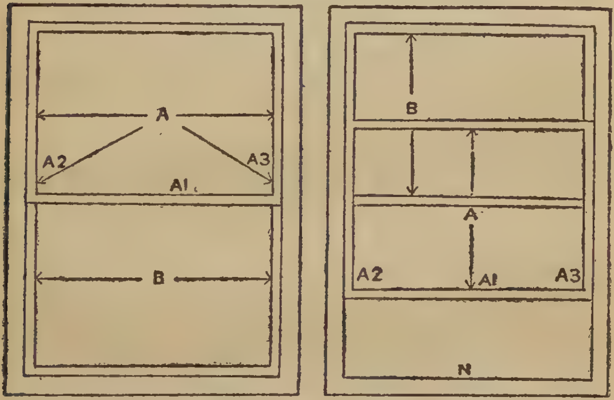


Fig. 2.—How to Paint an Ordinary Counter-balanced Window

easier job can be carried out if all fittings on woodwork be unscrewed and removed before painting. These should not be replaced until the finished work is quite dry and hard, for subsequent removal will chip off the new paint owing to the fittings having stuck thereto. A little tallow on the back of fittings is a great help in preventing this fault.

All damaged and defective woodwork or plasterwork which is adjacent to the paintwork or has to be painted should be repaired or replaced before commencing operations, to ensure an equal number of coats being applied. In the case of new wood, all knots should be coated with white knotting, obtainable at any oil-shop. This is a quick-drying preparation and the surface can be painted

over in half an hour after application. Good work is often spoilt by the appearance of brown blemishes on an otherwise good surface because the knots have not been treated in this way. A knot is really the end grain of a tree branch, and will absorb more paint or colour than the side-grain surfaces. The knotting will remedy this by closing the grain.

Glasspapering, particularly on wide surfaces, should be done by placing the paper on a block of cork about 4½ in. by 3 in. by 1¼ in. The cork, if knocked on any edges, will not do any damage. For stopping holes and hollows a stripping knife broad enough to overlap the complete hole will remove any surplus material on the surface. A sheet of newspaper inserted under a door will collect any spots that may drop, and save the floor and its covering.

For straining paint, a piece of old silk stocking free from holes can be tied over the top of a clean can or similar receptacle. By working gently at the paint with a small brush as it is poured through, it will soon be cleared of grit.

Hard-gloss Paint.—This can be made to yield excellent results, comparable to those produced by enamel. The working method is the same as for enamel, but it is advisable to use the particular grade of undercoating recommended by the makers. This is usually very reliable, and easy to work. The hard-gloss paint has generally more covering power than enamels, and is a trifle easier to apply. Turpentine, if used sparingly, will not spoil the gloss of either enamel or hard-gloss paints. The better enamels if slightly warmed will work much easier, especially in cold weather. Cellulose paints should never be put on top of ordinary oil paintwork of any description. When using this finish, all old paintwork must be removed and the woodwork properly prepared and undercoated with the cellulose undercoatings obtainable from the makers or suppliers. This paint is highly inflammable and care must be used when working with it in the vicinity of naked lights. The instructions issued by the makers should be carefully followed. Rubber-set brushes are necessary when applying cellulose finishes.

PAPERING A ROOM.—Paperhanging, to be well done, necessitates some little preliminary expenditure

on tools. These, however, will pay for themselves over and over again, time will be saved on the jobs, and the finished work will be much more satisfactory. The tools required are a really good bristle distemper brush of about 8 oz., a wheel trimmer, a bristle hanging brush, a pair of paperhangers' scissors, about 10 in. long, and a plumb line. A paste-board is made from two 6-ft. lengths of 11 in. by ½ in. deal; it can be laid on a table, or on trestles made for the purpose.

These tools will last for years if proper care is taken of them. Never use the paste brush without first soaking it in clean water for at least an hour before it is needed, or the bristles will fall out and the brush be ruined. Do not wash the hanging brush in hot water, nor allow either brush to rest on its bristles when drying or when out of use, or they will become permanently twisted or bent.

Wall surfaces should be bare and flat and should be sized in every case. If sizing is omitted, the paper will not slide to its proper position easily, and tearing of the paper, which becomes very soft after pasting, may result. Most English papers are 12 yd. in length per piece and about 21 in. wide after trimming.

Measuring up.—This can be done as follows: find the distance from top to bottom of the wall to be papered; ascertain how many lengths can be cut from a piece; then, with a rule, or a piece of stick 21 in. long, find out how many widths will cover the walls horizontally. A division of this number by the first—the number of lengths to a piece—will give the number of pieces required, less an allowance for doors, fireplaces, etc.

Papers of large pattern may be "drop" or level matched. The larger the pattern, the greater the allowance that must be made for matching waste. A study—before cutting—of the pattern which occurs at the end of each piece will enable a saving to be made, amounting sometimes to a full piece. Trimming requires the guide of the tool to be properly adjusted to remove the selvedges. As the edges are not usually of the same dimension, all the paper should be first trimmed on one edge, the trimmer again set, and the opposite edge trimmed. A sweeping motion, keeping the guide gently pushed against the paper edge, will give the best result, and if the paper

be first torn at the corner before commencing a roll, the wheel cutters will start to cut easily and freely. Trimming with the scissors is a longer and more difficult task. At some shops where wallpaper is sold, it can be trimmed for a small extra cost.

Before cutting the paper ascertain how many long lengths are needed for the whole room and match and cut all of these first, allowing about 3 in. extra at top and bottom.

Paste.—This should be of medium creamy consistency for thin papers, and thicker for heavier papers. Cheap and thin papers should be allowed to soak with the paste for approximately two minutes before hanging, or they will wrinkle up after hanging, owing to the stretching which takes place. A study of the behaviour of the first length hung will indicate the correct time of soaking.

When pasted, carefully fold the length, with a longer fold for the top than for the bottom. Commence on a straight wall requiring several long lengths, hanging the first one by a door frame or by a corner which has first been tested with the plumb line to see whether it is vertical. If the first length should not be hung vertical, the corners of the room will look very odd.

When pasting the paper, always draw the brush *away* from the edges and ends, to avoid the paste damaging the face of the paper. Do not miss any part of the paper; work in a good light, where the wet paper is reflecting the light and therefore any parts left unpasted will be seen at once. Having arrived at a place where a shorter length is required, take a remnant that is uncut, measure and match the length or lengths needed, and paste and hang them in continuing around the room. It is unwise to leave any section unpapered, since the pattern is bound to be lower or higher when filling in later.

A point occurs in every room where the matching has to be "faked." A spot must be chosen for this where the discrepancy will be least noticeable. Choose, therefore, a corner where the jointing is short. If the door comes in a corner, there is only the section between the door top and the ceiling or picture rail as a matching edge, and this location will generally be found convenient for the purpose.

Plenty of paste should be brushed on the paper, to

enable each length to be pushed into its proper position on the wall. Only in this way can a perfect joint and match be made to the previous length of paper. Attach the paper from left to right, by unfolding the top and taking the top corners one in each hand, carefully avoiding the floor. Place the top left-hand corner on the wall, at the same time keeping the right hand a few inches away from the wall. With the left hand push the paper into its exact position, at the same time glancing down the left-hand edge to obtain the vertical line.

Slightly stretch from hand to hand, and attach the right-hand corner to the wall; next sweep the paper gently with the hanging brush for about a yard down its centre. Run the fingers along the top line, mark with the scissor point—or a pencil if the paper is dark; cut paper and brush it on, making sure to exclude all air from behind the paper. Cut the bottom, and make certain all edges are well stuck before proceeding with another length. Where a moulding occurs, or uneven cutting is necessary, a pencil (not an indelible one) may be used to mark the paper, after first pushing the paper well into the angles to avoid tearing.

It is wise to pick out with the eye some prominent part of the pattern, about one foot from the top of each length, to facilitate matching. When hanging, the eye should be level with the top of the paper and in front of the left-hand edge on each occasion. Any edges which become unstuck in drying should be pasted afresh by inserting a little paste with the blade of a thin knife. If too much paste is inserted it will squeeze out and mar the face of the paper.

Ceilings.—For small ceilings the paper is folded, hung and cut in almost the same manner as for a wall. The scaffold used must allow the top of the head, when standing upright, to be about 3 or 4 in. below the ceiling. The supporting board must be immediately below the section to be papered. On large ceilings the paper is to be folded about 2 ft. at the end first pasted, and then short-folded for the remainder of its length. The multiple folds are then placed on a good remnant held by the left hand. The single fold is to be attached and matched, and the other folds allowed to unroll one at a time off the remnant and be brushed on as progress is made.

Never apply paper on to either new or old distemper. The distemper should first be sponged off or sized, as it will certainly absorb the paste and eventually cause the paper to come unstuck.

When a fitting of any sort is encountered the paper is to be cut across in line with the centre, if the fitting is round, or with the edges if the fitting is a square one. Then the paper is to be "starred" by making a number of cuts radiating from the centre, laid into its position, marked and cut, and finally fixed.

Always put away the tools in a clean condition; oil the metal ones and wash out the brushes, and they will then be ready and in perfect condition for the next job.

PLASTERED WALLS, REPAIRING.—The operation of mending cracks and damaged places in a plastered wall—especially if the latter be a partition wall built upon a foundation of laths and studding—is practically identical with the method employed for repairing a damaged ceiling; and for the proportions and instructions for mixing the various "stuffs," or plaster, as well as other detailed directions, the reader is referred to the article on CEILING REPAIRS.

However, a few words on the general procedure may be useful. First of all, the broken work must be thoroughly cleaned down. If the wall is lathed, the broken laths must be removed, taking them right back to the studding to which they are fastened, and new laths must be nailed in their places. All fragments of broken and cracked plaster that surround the repair must be cut out with the point of a trowel, and the outline of the repair must be reduced to as neat and even a form as possible, all sharp angles being avoided. The edges must be firm and uncracked. Where the plaster has fallen away from a brick wall, the latter must be cleaned of all loose fragments that may be left clinging to it, and the joints of the brickwork should be raked out with a pointed iron tool. The work must then be well brushed, in order to free it from dust, which would prevent the plaster from adhering properly; and, lastly, the edges must be thoroughly wetted. The wetting should be very thorough in the case of a brick wall, in view of the porous nature of the latter.

The repair will be carried out in two coats, "plaster"

and "float." The first coat must be pressed into the groundwork—either brick or laths—and edges of the old work, in order to afford it a good key. It should be finished off fairly level and brought forward to about $\frac{3}{16}$ in. from the finished surface. The damp plaster should then be scratched or scored over, and left for a day or more to harden.

If—as sometimes happens in the case of brick walls—the plaster has fallen away over such a large area that a section of the wall has virtually to be replastered, the first coat should be made more tenacious by the addition of clean, beaten-out cow-hair, as is described in the article on CEILING REPAIRS; in this case, too, the plaster should be put on in three coats, "plaster, float, and set."

The finishing, or floating, coat is to be applied when the first has dried and is to be worked off perfectly flat and smooth with the float, this tool being used with a curved stroke. Cracks and small holes can be filled up in one operation, using Parian or Keene's cement, but for large repairs two coats of stuff, at least, are essential.

Very often the plaster is broken away from the projecting angle of a wall, in which case it is not possible to attempt a repair quite in the ordinary way. Instead, bring forward the first coat to about $\frac{3}{16}$ in. from the surface, and float off one face of the angle to as near the broken edge as possible. When the plaster has set, lay a smooth board against the finished work and float off the other face of the wall, bringing the moist plaster right up against the wood. The latter can then be removed, so that finishing touches can be given to the first wall.

WATER TAPS, FITTING NEW WASHER.—As soon as a water tap fails to shut down tightly a new washer ought to be fitted. Even a tiny leak, if allowed to go untended for some hours—to say nothing of days—wastes a considerable amount of water. If possible—it is essential when dealing with a tap on the main—the supply is to be shut off at the nearest valve. After this has been done, open tap several turns. Next, with a set spanner of the proper size, unscrew the tap at the point where the two flanges meet. The spanner is applied to the hexagon nut above. It may be a left-handed thread that joins the barrel to the tap body. Steady pressure

is required, supporting the tap body with one hand to avoid any strain upon it or upon the joint to the pipe.

Unscrew the barrel, which will come away with the handle. The loose jumper is to be pulled out of the tap body if it has not come out with the handle and barrel. Unless the screw or nut of the jumper has become corroded, all that remains is to loosen and remove the nut, to take off the remains of the worn washer, and to replace the latter with a new one of the same material. Half-inch bore is the usual size for taps on a high-pressure main, and a washer for a tap of this bore should have been purchased in readiness.

If the home mechanic lacks a set spanner of the proper size for the hexagon nut on the tap barrel, an adjustable spanner or a pair of "grips" may be used. Beware of damaging the nut by using a badly fitting spanner, or by allowing the tool to slip. Failing a spanner, a small vice can be screwed up to grip the hexagon, and the barrel turned by this means. If the jumper is corroded, the best plan is to substitute a jumper having a washer permanently fixed to its under side. These can be bought at any ironmonger's shop for a few pence. Until the handyman opens the tap body he is "in the dark" as to the precise sort of replacement needed.

Hot-water taps require a washer of a special composition material that will stand heat. If the water cannot be shut off from the tap—it is usually difficult in the case of a hot tap or one at a bath or hand-basin—the operator must be prepared to make a quick job and to waste a certain amount of water. If possible, open a tap at another point in the same system to lessen the pressure at the tap to be repaired. Waste can be avoided by drawing off the water into the bath. Have ready a swab to place over the open tap body when the barrel is taken off. This will deflect the upward stream of water and break its force. Carry out the replacement as speedily as possible and screw on barrel again. Do not omit to open the tap, by a few turns of the handle, before attempting to screw on the barrel.

In the case of the hard fibre washer used on hot-water taps, the hole in the centre may need opening out a little with a reamer or a broach before the screwed spindle of jumper will enter. Such a tool should be held in readiness.

On the more ornamented taps, like those used in the bathroom, the hexagon may be concealed by a skirt screwed on outside. The handle of the tap, in such a case, is fixed to the spindle by a set-screw. This latter is to be taken out and the skirt unscrewed. Protect the jaws of the grips with some rag before closing the tool on the skirt of the tap, or the latter may be marred or damaged.

Occasionally the packing in the stuffing box or gland that seals the spindle at the top may need replacing. If water leaks at this point, unscrew the milled nut of the gland, take out old packing, and press in some teased-out string around the spindle. Then screw down the nut again. The tap may leak at the flanged joint between barrel and body, when a new washer or new packing is to be fitted.

With a commendable foresight, some water-supply companies will fit new washers to taps on the main, making no charge for this replacement. They will not, however, deal with taps of any other sort, such as those in the bathroom or the ball-cock on the tank. Directions for fitting a new washer to a ball-cock are given in the article BALL-COCK TO CISTERN.

WIRELESS RECEIVER, CONNECTIONS TO MAINS.—Many undesirable means are adopted to enable the wireless enthusiast to bring power to his mains-energized wireless set. Whether it be a home-made set with an eliminator or a properly constructed mains set, it should be provided with a separate means of supply from the house service.

A flexible taken from a ceiling point or the lampholder by means of a 2-way adaptor is unsightly and often dangerous. Even the common practice of taking the current from a plug socket near the fireplace may not be free from danger. Such a plug should be used for wireless alone, or reserved for the table stand.

Those who have a lighting plug socket on the skirting are in a fortunate position, for it is a comparatively easy matter to take a pair of wires from the terminals to a point near the wireless set. It can be done in the manner to be described. Obtain a small baseboard such as is supplied for electrical purposes, and large enough to take the following accessories: one linked tumbler switch; two

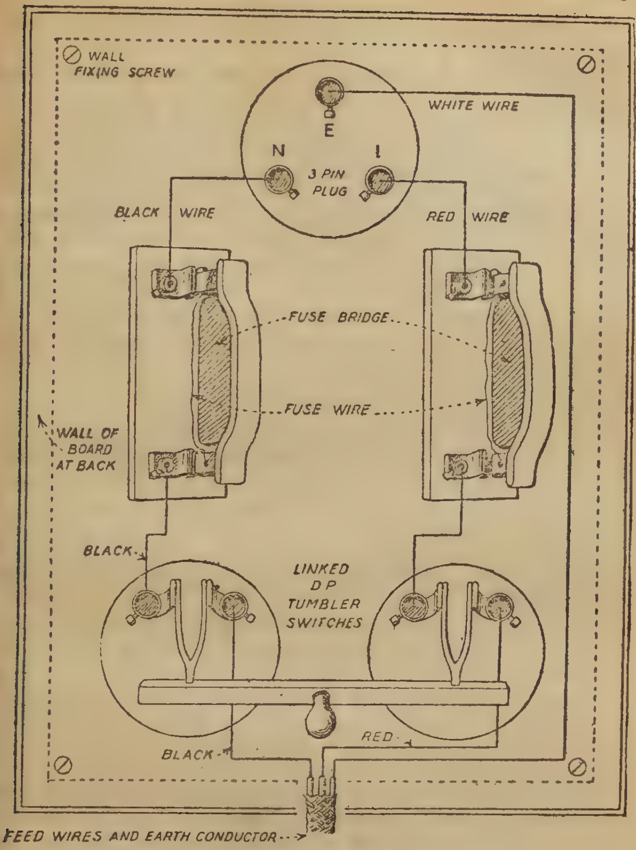
bridge-type fuses and a 3-pin wall plug, all of the size known as "5 ampere." Mount these accessories on the baseboard, putting the switches at the bottom, the two fuses above them, and above these the plug. Mark off the fixing holes, and the positions of the holes through which the connecting wires are to pass. Drill the latter holes and also a hole through the side of the board for the passage of the feeding wires.

Obtain a length of triple rubber or lead-covered wire long enough to reach from the existing plug to the spot where the wireless plug is to be fixed. Run this wire round the wall, utilizing the corners of the room, skirting-boards, or picture-rails to keep it as inconspicuous as possible. Procure sufficient saddles and nails to enable one to be placed every 12 or 15 in. The saddles used for rubber-covered cable are not the same as those used for lead-covered wire; and the proper sort must be obtained.

With some ordinary electric lighting cable, wire up the baseboard itself. Short lengths will be required, with the insulation stripped off at each end. Start from one of the tumbler switches; connect the end of one piece of wire into one terminal and the other end to a terminal of one of the fuses. From the other terminal of this fuse connect a second wire, the other end of which is to be connected to the nearest terminal of the plug. Then start again from the second tumbler switch, wire up through the fuse to the plug, using the other fuse and the spare terminal of the plug. There are three plug terminals, but the large one will be left for the time being; connect only the two smaller ones.

Leave the connecting wires fairly slack, but let all the insulated portion pass through the holes in the board, with only sufficient bare wire protruding for the actual connection to the terminal. All wiring is, of course, at the back of the board, which should be provided with a recessed cavity to accommodate it. Drill a fixing hole in each corner of the baseboard and mark on the wall the positions the screws will take when the board is screwed up. Punch holes in the wall and insert the plugs. Use the household rawlplug tool and plug for these.

Strip 3 or 4 in. of the rubber or lead covering from the feed wire and push the ends through the hole drilled in the side of the board, so that the main rubber or lead



POWER CONTROL FOR WIRELESS SET

covering passes well behind the board. One of the bared ends of this wire—the red one—connects into the spare terminal of one switch, while the black one goes to the spare terminal of the second switch.

Now for the third wire—the white one: this will go straight to the plug, where it will be connected to the

"earth" terminal. This terminal is often the largest one of the three.

In order to complete the earth conductor a triple-wire flexible is used between the wireless set and the plug-top, where the white wire is connected to the larger of the three pins, and the other end to the earth terminal of the eliminator. The other two wires are connected to the plug-top terminals so that when the top is inserted in the base the pin to which the red wire is attached enters the socket to which the red feed wire is connected. It is not possible to insert the 3-pin plug-top in any but the right way.

Having made all the connections this board can be fixed to the wall and left while attention is given to the other end of the feed wires.

Before going any further, switch off the current at the main switch near the supply company's service. The final operations form a daylight job. Remove the cover from the plug base and unscrew the base, loosening the screws holding the wires as well. Take off the base from the block and remove the block from the wall, first marking the spot adjacent to the feed wires so that a hole can be drilled here for them to pass through. Here again the outside protected portion will come through the wall of the block.

Separate the three wires of the feed, making each sufficiently long to pass out again through the block and to the plug-base terminals. Thread these ends through the block, using the existing holes—which must be enlarged if necessary. Let the new red wire follow the existing red, and twist the bared ends together, doing the same also with the black. The white wire is twisted to the "earth" wire, if one exists; if not, this end should be extended by a length of wire and so carried on to a water pipe. A porcelain-covered connector should be used to make connection with a piece of single-stranded copper wire running away to the nearest available water pipe.

Having threaded the wires and joined up the ends, refix the block to the wall, using the old screw holes. Connect the plug-base and refix this also, finally replacing the cover. Now take two pieces of "1-amp." lead fuse wire, and fit one piece across each of the fuse bridges, afterwards replacing the bridges in the fuses on the board.

Insert the plug-top and put the switch in the "off" position until the main switch has been closed.

When the main switch has been turned "on," listen for any small noise from the fuses near this switch. Nothing will happen if the new wiring is in order, and the worker can then put the linked tumbler switches to the "on" position and start up the wireless set. If the main circuit fuse "blows," it indicates a fault somewhere between the old plug and the new board, which must be located and put right before we can go any further.

It must be clearly understood that the supply is to be taken from a plug fed from the electric-lighting service and *not* from the heating or cooking services. Where there is not a conveniently situated plug from which to take a supply, it is far better and more straightforward to run right back from the new board—which will be wired up exactly as already explained—to the main circuit fuses, where the connections must be made to the terminals the more remote from the main switch. The latter must, of course, be in the "off" position before the fuses are touched. The electric current must pass first through the fuses before traversing the wires to the wireless set.

The "earth" wire spoken of so far is that which protects the electric circuits of the house supply against danger from faults arising in the wiring, and has nothing to do with the wireless earth, which should be kept quite separate. By following the foregoing instructions the usual regulations governing the electric supply to wireless sets will have been complied with.

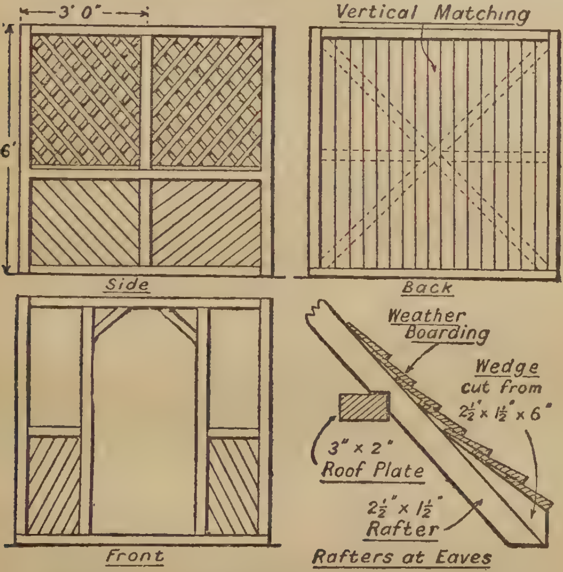
Indoor and Outdoor Woodworking for the Home Carpenter

ARBOUR or SUMMER HOUSE.—Though arbours are often made octagonal in plan, this shape involves some difficult work in dealing with the angles and the roof, and a structure of a rectangular plan will be the best for the amateur to attempt. The one to be described is 6 ft. square by 6 ft. high to the roof plate, though with the timber specified it might quite safely be made a little larger. It has a weather-boarded roof, but this could be close-boarded instead, and covered with one of the special roofing materials. A diagram is given of a side, and of the front and back. The side is panelled in match-board to a height of 3 ft., the matching joints running diagonally. Above this part the sides are panelled in trellis. The back is boarded with matching, set vertically. It is strengthened by two diagonal braces that cross to form an X. Horizontal studs are also fitted in and nailed. The front has two narrow panels of matching and is open above.

The foundation is the first thing to consider. Concrete is the best, and it should be sloped to give a "fall" from the back to front, to avoid water lying on the floor. The angle-posts are of 3-in. by 3-in. deal, tenoned to a 3-in. by 2-in. sill laid on the concrete, and to a 3-in. by 2-in. roof-plate above at a total height of 6 ft. The intermediate verticals on the sides and front, and the horizontals, are of 2-in. by 2-in. deal, and this timber is used for the studs and diagonal braces of the back. A halved lap joint is employed at the crossing of horizontal and vertical on the sides, and the horizontals are tenoned into the angle-posts. On the front the two short rails are tenoned to angle-posts and door-posts.

When the structure has been framed up, the matching

panels can be cut and fitted to sides and front. If the worker feels temerity in cutting the diagonals, he could fit in ordinary matching having vertical joints. The boards rest against a fillet of inch stuff nailed to the framing to form a rebate. The diagonal trellis that is used for top panels of the sides is dealt with similarly, and tacked to the fillet. The braces of the back wall

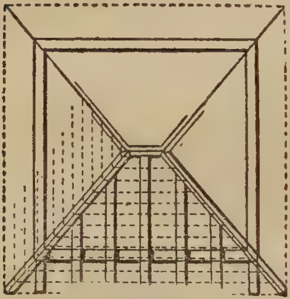


WORKING DRAWINGS FOR SQUARE ARBOUR

come inside the matching. They are halved together at the intersection and butted to the framing—a good, tight fit being essential. Two brackets or struts are shown from door-posts to roof-plate.

Roof.—This has a short ridge, for ornamental purposes. The ridge-board (6 in. by 1 in. by 1 ft. 6 in.) is supported temporarily by two notched pieces of board fixed to two lengths of quartering spiked across the roof-plate at the proper distance. The hips are of 3 in. by 2 in. cut off at the requisite angle, butted against the ridge-board, and

nailed. At the outer end, they and the rafters project a foot beyond the roof-plate. They are notched to the latter and nailed. A bevel-square should be set to the proper bevel and the timbers marked with this. Accurate cutting is essential. After the hips are up, the intermediates should be fixed to ridge-board and roof-plate. These rafters can be of $2\frac{1}{2}$ in. by $1\frac{1}{2}$ in. stuff. Make sure that they are fixed level with the hips and with each other.



ROOF IN PLAN

Rafters are to be sawn off at the length arranged, so that the eaves are the proper dimensions all round. The appearance of the eaves can be improved by giving this part of the roof an upward cant as compared with the rest. It is done by nailing to the foot of each rafter a wedge-shaped piece cut from the $2\frac{1}{2}$-in. by $1\frac{1}{2}$-in. deal. The butt of the wedge forms a right-angle with the horizontal foot of the rafter. The arrangement is shown in the sketch on page 67. It is recommended that the roof be boarded with good-quality feather-edge boarding. A rough gauge can easily be made for use in laying this.

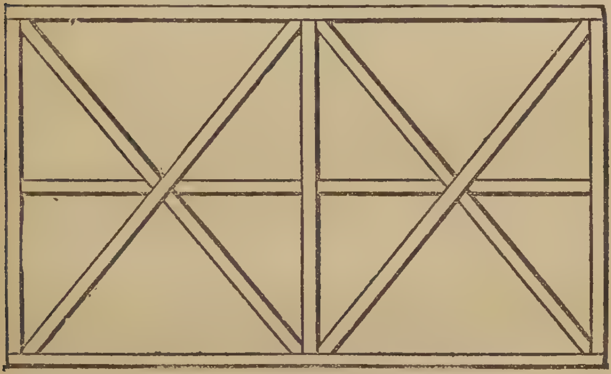
The back of the arbour can be match-lined inside to cover the diagonal braces. A seat at back is easily made.

FRONT OF 10-ft. BY 6-ft. ARBOUR

Larger Summer House.—For the handyman who desires a larger summer house it is suggested that the length should be extended to 10 ft., keeping the sides the dimensions already given, i.e. 6 ft. The back in this case will have to be divided into two bays by a centre post, each

diagonally braced. The front can be modified to make the panels of matching the same size as those in the sides of the arbour, leaving a 4-ft. doorway.

The door-posts should be of 3-in. by 3-in. deal, like the angle posts, and a stiffer rafter (3 in. by 2 in.) placed where each door-post joins the roof-plate, and at the back to correspond. Much of the charm of an arbour—such as the one described—depends on the wide eaves, and if this part of the work is carried out according to instructions the effect will be artistic and satisfying. As a finish



BACK OF 10-ft. BY 6-ft. ARBOUR

a semi-circular platform in concrete may be made at the front, a foot wider than the doorway opening. The concrete foundation of the arbour can with advantage be extended 18 in. at each side, and at the back unless the arbour stands close against a fence or wall. Several coats of creosote, or one of the coloured outdoor stains, should be applied as soon as possible after completion. Alternatively, the arbour can be painted.

It may be unnecessary to point out that the erection of such an outside building should be left until two or three dry days are likely, since it is important to get the woodwork creosoted or painted before it becomes wetted. All the preliminary work can be done in readiness beforehand, and the concrete base prepared, so that the actual upraising of the arbour can go ahead when a favourable

occasion arrives. In reading the diagrams, it must be borne in mind that although each part—side, back, and front—is shown complete with framing, the same angle-post serves for the adjacent side and front, or side and back, as the case may be. The angle-posts are 6 ft. apart from outside edge to outside edge, whether measured over side or back or front.

A portable structure would be made up in four body sections—two sides, back, front—each with its frame, of course, and the sides would come outside the front and back. If 6 ft. square was the dimension determined on, the length of the front and back would be less than this by the thickness of the two posts that enclose each respectively. A hipped roof would not be practicable for a portable arbour, but an ordinary span roof would suit. These explanations are given here to avoid any misunderstanding in dealing with the sketches. Details of portable buildings will be found in the article on SHED IN SECTIONS.

ARCHES FOR THE GARDEN.—When building arches or making trellis it does not pay to use cheap materials. The labour is no more when stouter stuff is employed, and the jobs will stand three times as long in the latter case. Ready-made arches and screens are offered at a temptingly low price—to be bought by novices who forget that such frail and light materials cannot withstand our weather.

Posts for an arch should be $2\frac{1}{2}$ in. by 2 in. for light jobs, and 3 in. by 2 in. for anything else. Since the material will be purchased "prepared"—i.e. planed—this section will be somewhat less than the nominal measurements in any case. Butts of all posts should be tarred or creosoted to protect them from rot. The laths must be stout ones, at least $\frac{3}{8}$ in. to $\frac{1}{2}$ in. thick. Those used for lath and plaster partitions are not suitable. Special flat-headed cement-coated nails can be bought for fixing laths to framing.

After the sides of the arch are framed up and the laths attached, the whole should be creosoted twice, or given two coats of paint; the rest of the timber also should be creosoted or painted when it has been cut and fitted. Tenons and any other joints must be coated with paint before fixing. When erecting an arch dig out the holes

2 ft. deep for the two sides, stand these in and chock with a piece or two of brick or rubble while a rough level is taken and the sides are aligned. Fill in earth and ram down sufficiently to hold frames steady, and make a further adjustment. The sides can then be boarded temporarily by nailing a couple of battens across the archway, and the filling in and consolidation completed. Next the crossbars and top are fixed, and a few necessary touches of paint or preservative will finish the job.

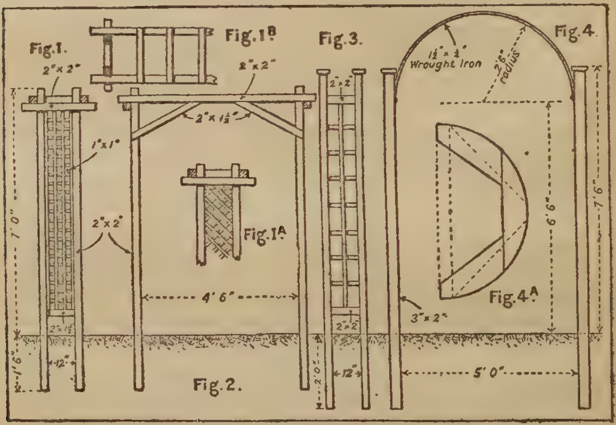
If the posts or sides are concreted in, a much more durable job will result. Ram the concrete well down and allow a depth of about 8 in. Then replace earth to the ground level. A rammer can be made from a length of old putlog, fixing in a short piece of broomstick at the top and another at one side, some 8 in. down, as handholds. This makes a very useful implement for a hundred and one jobs, and is just heavy enough for the purpose without proving too tiring in use.

Designs.—Two styles of arch are depicted, and they can both be modified to suit the home constructor's personal taste. No. 1 is within the scope of the least experienced; whereas No. 2 demands some experience in making simple joints and a little manual skill. The first, shown in Figs. 1 and 2, is in a style that can also be used for simple pergolas. It is for an arch to accommodate roses or such other plants as clematis, and provides a strong and pleasing structure in spite of its simplicity. The essential dimensions are shown in the diagrams; if these are modified, the proportion and balance should be preserved.

The posts, of 2 in. by 2 in., are connected at the top by two crossbars that are halved to them and project 4 in. outside. The lower rails are of 2-in. by 1½-in. stuff, let in flush with the outside of the arch. To form a rebate, a length of 1-in. square stuff is nailed to the inner side of each post and other pieces to the top rail. The laths that form the square trellis are fixed to this or to the inner face of lower cross rails, as the case may be. The effect is that the trellis is practically flush with the inside of the arch.

When the sides have been erected the top bars of the arch are fixed by notching them to the front of the posts,

nailing them through, and skew-nailing to the projecting ends of the side rails on which they rest. The diagonal braces at top are let into the posts at lower end and halved to the inner side of top bars at the top end. Use a bevel square to ascertain and mark the angles for the shoulders of braces; failing this implement you can employ a folding 2-ft. rule that does not work too loosely, opening the hinge till the arms of the rule are at the desired angle to one another. Hints for these and other jobs and



FIGS. 1, 2, 3 and 4—DESIGNS FOR ARCHES
Fig. 1A—Diagonal Trellis. Fig. 1B—Plan of Top. Fig. 4A—How to build up Template

diagrams of the joints are to be found in articles on the various JOINTS.

When the braces or struts have been attached the roof of the arch may be filled in by nailing pieces of 1½-in. by ¾-in. batten across from front top bar to back bar. For a neat and workmanlike job these battens might be let-in half an inch by notching the bars before they are fixed, so that the battens stand up a quarter of an inch above the crossbars. A plan of the top is shown in Fig. 1B. An alternative way of filling in the panels of the sides is to use diagonal trellis, 1 ft. wide, as shown in Fig 1A.

In the second design, shown by Figs. 3 and 4, we come to a somewhat different method of framing, by mortise

and tenon. The posts, of 3-in. by 2-in. material, are joined by rails of 2 in. by 2 in. tenoned and pinned to them. The panels are filled in with 1-in. square stuff, the ends being tenoned into posts and rails, and the crossings being halved together. In this form of tenon—a stump tenon—the member is let in full size to the mortise. Set out and mark the posts and rails carefully, making sure that the joints are square, and that the holes for the filling are identical on each post.

It will be clear that the assembling of frame and filling must proceed together, the 1-in. square pieces being fitted into place into one post and into the two rails, and the second post then eased on. The mortises for the vertical and crossbars must be tight, cleanly cut, and square; the ends of the filling may be pared a trifle to ensure they enter. Try the sides together; then give the joints a coat of paint or creosote, according to the finish being used, before final assembly. Gentle blows by a mallet will help the tenons to enter, but if they need forcing they should be eased a little.

A $\frac{1}{2}$-in. hole can be bored clean through each joint of the rails with posts, and a pin, made of $\frac{1}{2}$-in. dowel, driven home and cut off level. Try the drill-bit in an odd piece of quartering first, and insert a piece of dowel to make sure the latter will be a tight fit in the actual job and so hold tenon securely.

The top, or roof of the arch, is made from two flat iron hoops connected by iron cross pieces. The hoops for the size specified are bent to a radius of 2 ft. 6 in. and form almost a semicircle. The local smith will supply the material—$1\frac{1}{2}$-in. by $\frac{1}{4}$-in. wrought iron—and also punch two holes in each end for $\frac{1}{4}$-in. coach bolts, that will hold the iron hoops to the posts. Drill holes in the hoops for the cross pieces, and also in the latter. They are attached with rivets. It will be a help in bending the hoops if a wooden template is made up from odd scraps of 1-in. board and then sawed to the proper shape —a semicircle of 2 ft. 6 in. radius. Fig. 4A shows how to build up the template, the dotted lines indicating the battens that hold together the shaped pieces. Two coats of lead paint should be given to the ironwork.

AVIARY.—An outdoor aviary is not very difficult to construct, and with its chosen denizens it is a continual

source of pleasure and interest. It must comprise a warm and weather-proof shelter, and an ample enclosure where the birds can fly. The shelter is constructed in the same way as a shed, covered with weatherboard or stout matching, and roofed with prepared felt, or one of the proprietary materials, over close boards. For a really sound and nice job moulded T. and G. or rebated weatherboard might be used. The former has a better finish and is weather-tight.

Concrete Base.—The base on which the aviary is to stand should be levelled and concreted, arranging a slight fall to the edges to prevent water lying about. The aviary can be constructed as a portable building, in

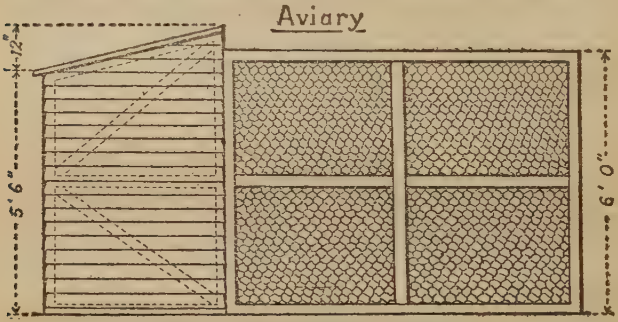


FIG. 1—DIAGRAM OF AVIARY

sections to bolt together. The frames are anchored to the floor by rag bolts let into the concrete and projecting through the timber. The bays of the enclosure can be made of a size to take the width of netting that is being used for a covering. The netting should be carefully and closely stapled to the framework, a stout galvanized wire being run through the edges to stiffen them.

Use of Angle Iron.—An alternative method of framing the enclosure is to use angle iron, drilled and bolted together, for the bars and rails. The amateur who has a few metal-working tools will find this an interesting task, and if he does break a few hacksaw blades they are cheap enough to-day. A bench drill would lessen the labour of drilling the holes, and almost pay for itself on the job. The ironwork should be painted two coats, and galvanized

stove bolts used to assemble the frame members. When the front, back, and end sections were up, the roof bars would be bolted to them and the netting then attached on top.

Entrance Door.—A double door must be contrived, so that anyone can get in without the birds being able to escape. This is really a sort of "lock," and consists of a small enclosure separated by wire from the rest of the aviary; it has a door flush with the outside of the house, opening inwards, and a similar door at the inner side of the "lock," also opening inwards. Normally the inner door is kept closed.

From the diagram Fig. 1 it will be seen that the en-

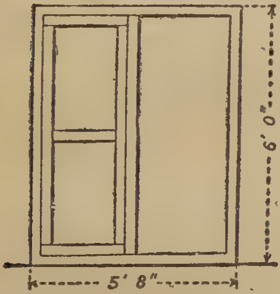


FIG. 2—FRAMEWORK OF DOOR

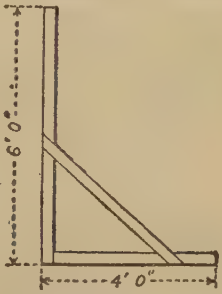


FIG. 3—TRY-SQUARE MADE OF WOOD

closure is very simple, the front, back and top sections being identical in dimension and construction. The end section, which contains the entrance door, comes between the front and back ones, but the top frame rests upon the top of the front, back and end, and is bolted down to them. The three sides of the shelter are framed up separately and bolted together independently. The lines of the framework are indicated in the diagram by dotted lines. In the article on SHED IN SECTIONS are many hints and instructions for this portion of the work.

Joints.—The frames for the enclosure should be tenoned together and pinned, taking care to preserve squareness. The crossing of the vertical and horizontal members of the sides and top needs a half-lap joint. The door-frames should be tenoned. When erecting the

aviary the shelter is first set up, and then the back and end of the enclosure put up. Next follow the front and the top. Good sound timber, free from "shakes" or "winds," should be used, and any piece that shows defects must be rejected.

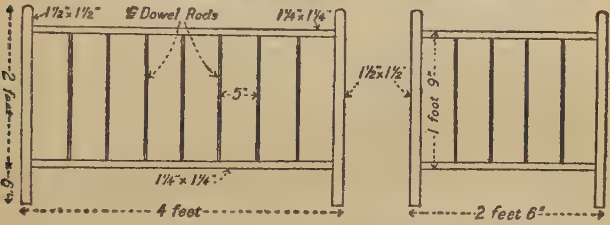
A very useful gadget for the handyman who has work of this sort in view is a 6-ft. by 4-ft. try-square made of wood (Fig. 3). It can be improvised from two lengths of batten held together by a brace across the angle. Set it with a trustworthy square and screw on the brace. Hang up in a dry place when not in use.

BABY'S PLAY-PEN.—When an infant gets to the age of a year he needs some safe place in which to play outdoors. The usual play-pen consists of a folding frame-work that forms an enclosure when erected. This is quite good for indoors, but not entirely satisfactory for the garden. It has to be stood on matting or on a rug, and the little one is too near the grass for this to be a hygienic arrangement.

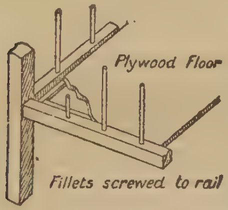
The play-pen to be described is somewhat like a child's cot, with rails of 1¼-in. stuff and a filling of ½-in. dowel rod. It stands up 6 in. from the ground on short legs and has a plywood floor. The sides of the enclosure are 1 ft. 9 in. high. The simplest form is a rigid, non-folding structure, and if it is made just wide enough to go through the doorway opening on to the garden it can be brought indoors at night or in bad weather. A folding pen demands more labour and skill, and is a job for the handyman when he has gained experience on simpler jobs.

The pen is 4 ft. by 2 ft. 6 in. or more over all, the width depending, as we said, on the doorway it has to pass through. The end frames are made up first, the rails being mortised and tenoned to the angle posts—these latter being of 1½ in. square section. The rails are bored for dowel rod at 5 in. centres, this being done after joints are cut and tried together. See that the twist bit is the proper size for rod by boring a hole in a piece of waste and trying in a piece of dowel. A good close fit is desirable. If the worker has a bench-drill he can probably use this for boring the rails. If the chuck will not take the usual square-taper shank of the bit, this part can be cut off with a hack-saw and the round part of shank will then go into chuck.

Fix up some sort of depth-gauge on the bit, and bore holes uniformly to $\frac{5}{8}$ in. deep. On the bench-drill this job will be easy, and the rails can be clamped for each hole. When using a brace for the purpose, take care that the holes are in the centre line and are upright. A line is gauged on the edge and the centres set off with a pair of dividers. Mark the points with a pencil or deepen them slightly with an awl so that the marks are not lost. Cut off the lengths of dowel rod—this should be bought in multiples of 1 ft. 9 in. so as to avoid waste—and prepare



WORKING DRAWINGS OF BABY'S PLAY-PEN



for assembly by cleaning the ends with sandpaper. Do not reduce the diameter unless necessary for entrance.

A cutting-gauge can be rigged up on the bench by temporarily screwing on a couple of blocks the proper distance apart. Cut one length and try before proceeding with the rest. When ready to assemble the ends, have hot glue ready: glue lower ends of rods and insert in rail, the latter having first been glued and tapped into angle posts a little way. Now carefully fit on top rail and insert tenons into mortises in posts. Try for square and cramp up. Drive a fine nail through rail and a midway post at top and bottom. The nails must be punched in carefully after glue is hard. Holes should be bored for nails. Place the ends on one side till glue has set.

When the ends are ready the long sides may be assembled by inserting rods and connecting rails to ends. The plywood floor is added later. It is screwed to

fillets screwed to the lower rail inside, and may be stiffened underneath by a batten if necessary. If the joints have been well made the pen will be strong and rigid; as a precaution it could be stiffened up by chair brackets screwed to angle post and underside of bottom rail. Clean up well with sandpaper and stain to shade desired. In this pen the "toddler" can play with his toys and amuse himself without coming to harm. He can draw himself up by its sides and learn to walk. It will give good service until the day when its little tenant manages to climb up and scramble or fall over the other side—and then its day will be done.

The dowel-rod uprights should not be too wide apart or the child may squeeze its head through. See that no rough edges or splinters are left anywhere.

BEADS AND BEADING.—In several articles in this book the handyman is instructed to use beads or "quarter rounds" for fixing in glass or panels or for ornamenting work.

An applied bead is usually more or less a makeshift, and the man who is satisfied only with the best will work his own beads on the job wherever this is practicable. Beech planes for beading can be bought for 3/6 to 4/- each, and a separate one is needed for each size of bead. A $\frac{1}{4}$ in. and $\frac{5}{8}$ in. are useful sizes, but the home worker can buy just the one he needs when he actually requires it. Then there are iron planes that take a variety of beading cutters in the same stock; but these are expensive and almost outside the utility range for the home worker. The irons of beading planes are sharpened with an oil-stone slip of suitable section.

BEDSTEAD IN OAK.—A strong and artistic wooden bedstead is not too difficult a job for the amateur. The one illustrated is 3 ft. wide—a comfortable "single" for a youngster or even an adult. It has a coil-spring mattress, the coils being supported beneath by dropped bars. The head and foot are furnished with iron "dovetails" that are fixed to the posts with screws, and the mattress frame has projections that engage in the dovetails and lock the bedstead together rigidly. If the worker possesses a suitable spring mattress on a wooden frame, this can be utilized; in such a case the head and foot of bed are linked by side-irons and the spring mattress lies on top

in the usual manner. Another form of bedstead-fitting has the side-irons attached to brackets by four bolts, the brackets, of course, replacing the cast-iron dovetails employed in other systems. This method is perhaps the best when a modern frame mattress is used.

Combination mattresses—such as those first mentioned —can be bought for about fifteen shillings a set, including dovetails; the coil-spring type costs twice as much but is worth the extra money. In between these come the better-grade woven-spring mattresses, with a straining-bar and bolts that are tightened up with a crank or a spanner.

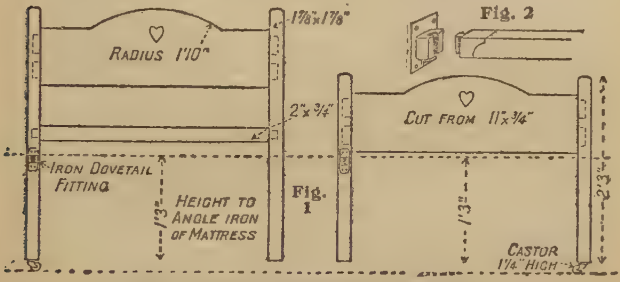


Fig. 1—SINGLE BEDSTEAD IN OAK
Fig. 2—IRON DOVETAIL FITTING

Whichever type is used, the fitting of dovetails is similar and presents little difficulty. The coil-spring type is recommended for comfort and simplicity. The mattress and fittings should be purchased before any timber is cut to size.

Head and Foot.—The posts are cut from 1⅞-in. by 1⅞-in. oak. Those for the head are 3 ft. high and those for the foot 2 ft. 3 in. A rail of 2-in. by ¾-in. stuff is stub-tenoned into the head, 1 ft. 5½ in. from lower end. The head-board is cut from 11-in. by ¾-in. oak; its lower edge is 2 ft. from bottom of posts. It is stub-tenoned into the latter. A simple fret may be cut with a coping saw; anything of an elaborate nature in the way of ornament would be out of place in a severely plain design like the present one. An alternative to a fret would be an applied rosette or ornament glued to the face of head-board. The foot is made up in a similar manner;

it has no rail, and the lower edge of board is 1 ft. 2 in. high, measured from the lower end of post.

Accurately cut joints and efficient gluing are absolutely essential to success in framing up the parts of a piece of furniture such as a bedstead, in daily use and subject to jolts and pushes during cleaning operations. An aid to the process of assembly is a couple of wooden cramps; this device consists of a flat wooden bar with a stop at one end against which the frame rests. A pair of folding wooden wedges is knocked in at the other end, between a stop and a block that protects the side of the job being cramped. As the wedges are driven home the frame is squeezed against the outer stop, and the requisite amount of pressure thus exerted. Two such cramps can be made up in a short time and if used only for the job in hand they will be well worth the trouble. The length of bar should be such as to take the frame, loose piece and wedges when the latter are partly inserted. If too free, an additional thin slip can be placed between wedges and loose block. In use, arrange the two cramps parallel on floor, glue up and insert bed head or foot, and tap home wedges equally in each cramp.

Fixing Dovetails and Castors.—The mattress is to be fixed at 1 ft. 3 in. from lower end of posts. The castors raise it about another $1\frac{1}{4}$ in. from the floor. See that the dovetails are screwed on level and square at the proper height and the correct distance apart. A simple gauge can be made from a lath in whose edges notches are cut to indicate the proper spacing of the brackets, or the positions may be merely measured and marked. Bore holes for screws just large and deep enough and screw them in tight; the strength and rigidity of the bedstead depend on the dovetails being accurately and strongly attached to the posts. Castors should be good quality ones, brass and not merely "brassed." They require to be put on with care. Bore the hole for the screw-prong and twist in firmly. Then drive two or three nails into the end of post through the holes in plate of castor. The nail punch will be needed to finish the job, so that heads of nails are driven home and do not project above to foul the wheel. Screws, it may be noted, are useless for this part of the job.

The woodwork can be finished according to taste,

being left light or darkened down to match other furniture. It may be french-polished, if the handyman is familiar with this operation; on the other hand it may be varnished or oiled after staining.

A double bedstead can be made up with practically the same framing. An additional rail could with advantage be provided at both ends to stiffen them in this case. It might well come about 5 in. from the lower end of leg. The dimension for a full bedstead is 4 ft. 6 in. wide. Bolted side-irons and brackets would be most suitable for this size, and above this might come either a wood-frame spring mattress or one of the box form with internal springs. Another idea is to make up a pair of 3 ft. bedsteads as "twins."

BENCH.—Some sort of bench is a prime necessity for the home mechanic. Owing to lack of space a fixed workbench is not always practicable, and either a portable one, or a bench top to clamp to the kitchen table, will have to be substituted. If the kitchen table is stoutly constructed and stands firmly, a great deal of work can be done on it. Procure a 9 in. by 1 in. board about four or five inches longer than the table and clamp it on the top of the latter, along one edge. Two stout G-cramps will be needed—do not be put off with cheap ones made of flat iron bent up at right angles.

The cramps must be placed on the plank where they will least interfere with the use of the space, and when a position has been chosen the end of cramps may be let in a little by chiselling out a shallow square recess for each. This will stop them slipping; a thin block must be interposed between the screw of cramp and the underside of table to prevent damage to the latter. On the end of the plank that juts out from the table a vice or some other tool can be clamped temporarily. The table should be pushed close to a wall and the edge prevented from marking the latter by a pad of cloth at each end. Then, when the table jars against the wall, as it probably will, it cannot mar the paintwork. When hammering, place the work over one of the table legs, where there is full support.

An extension of this idea is to make up a false top 18 in. wide, to clamp on the table. Two cramps at each end will be needed. The two boards forming the bench

top must be held together by a batten screwed on underneath, flush with the edges. The bench top will project over the table top at each end to the width of the battens. Fix the latter so that the bench just fits snugly over table. The two 9-in. boards ought to be glue-jointed or dowelled to each other. As a makeshift, knock into the edge of one board about a foot from each end two oval wire nails, leaving about 1 in. projecting. With a saw-file cut off the heads so that a chisel-like edge is left, and lay on the other board so that the nails mark the edge. Then with a fine bradawl bore shallow holes for the nails, place board on top, and tap home with a mallet. These improvised dowels will hold the boards together and flush.

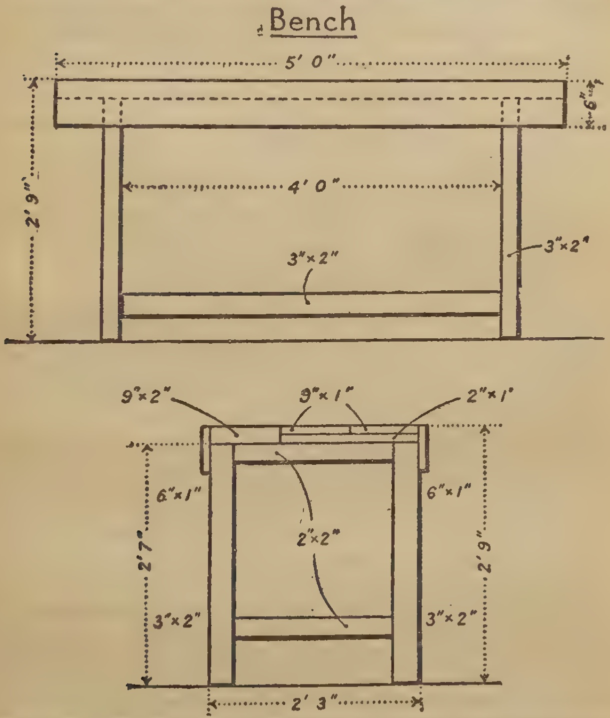
Making a Bench.—If the handyman intends to do much woodworking he will desire to make a full-size carpenter's bench as soon as possible, for of course the devices we have just described are only fit for light jobs. A bench calls for no great skill, and the joints used are simple mortise and tenon ones. What *is* necessary is firm and solid construction.

The height to top of bench should be somewhere about 2 ft. 9 in., though of course the size can be arranged to suit the owner. A tall man might like the top an inch or so higher. Length can be 5 ft. and width up to 2 ft. 3 in. (*see* note at end). The top is formed of three 9-in. boards, the front one being 2 in. thick and the other two of 1-in. or 1½-in. stuff. The thinner boards are levelled up to the front one by a packing-piece beneath each end.

Commence by making the two ends, of 3-in. by 2-in. legs joined by 2-in. by 2-in. rails at top and bottom. The rails should be tenoned into the legs and the joints pinned with dowel rod. The two ends are now connected by the long rails front and back, tenoned into legs. Note that these rails come lower down than those that join the front and back leg of each side. To steady the bench while the top is being attached, tack on an odd piece of batten or board at front and back near the top.

The thick top board is fixed to the top rail of the sides by two ⅜-in. coach bolts at each end, countersunk. The back boards of top are screwed down through packing-pieces into rails, using 3-in. screws. When the bench

top has been attached there remains the front and back cheek pieces to screw to the legs and to the edge of the top. The cheeks are of 6-in. by 1-in. stuff. A drawer can be made and fixed at one end, or half the under part can be enclosed to form a useful cupboard with racks and



WORKING DRAWINGS OF BENCH FOR THE HOME MECHANIC

shelves for tools. A bench stop and a woodworkers' vice can be purchased and fixed. A metal vice is more serviceable than the wooden one often seen.

A parallel-jaw metal-worker's vice ought to be fixed where it will not be in the way of carpentry work. A vice to clamp to the bench might be preferable, since it

is easily removed after use. For the man who does metal work there is nothing to beat a leg-vice fixed at one end of the bench; the leg gets a bearing on the floor and the vice is screwed down to bench top. Sometimes a second-hand leg-vice can be picked up in the market for two or three shillings—an excellent investment, as time and again the worker will appreciate a really firm and powerful vice.

Cutting List for Bench

The dimensions are net, and allowance for waste in cutting should be made when ordering timber.

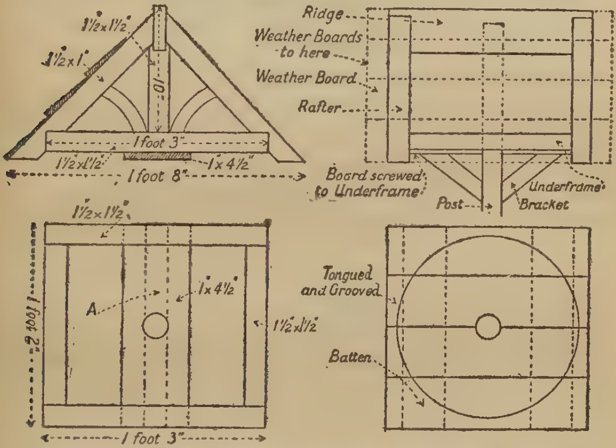
Legs	4 pieces	3″×2″×2′ 7″
Rails	4 pieces	*2″×2″×2′ 3″
,,	2 pieces	3″×2″×4′ 6″
Cheeks	2 pieces	6″×1″×5′ 0″
Top	1 piece	*9″×2″×5′ 0″
,,	2 pieces	*9″×1″×5′ 0″

****Note.*—Since prepared (i.e. planed) timber will be used, the scantlings will be a little less in section than the nominal measurements given. The top boards and cheek pieces need only be planed on one face and the edges. Measure the actual width of top across the three boards, before starting to cut side rails, and adjust the length of latter accordingly.**

BIRD-FEEDING TABLE.—The aim in building a bird table is to make it at once artistic to its human owners and acceptable to its bird patrons. A larch or fir pole forms the post on which this table is mounted. It should stand up 5 ft. 6 in. from the ground and go down 18 in. into it, so that a sound pole of 8 ft. in length must be procured in order to cut off the bad ends if any. The thickness should be 3½ in. at butt, and about 2½ in. at the point where the roof-frame is fixed, a foot from the apex. Remove the bark, trim end of butt square, and cut the top end to a notch that will cause it to engage with the lower edge of the ridge-board and afford a direct support to the roof.

Shave off knots, etc., with a spokeshave or draw-knife and clean up the top 2-ft. especially. The roof-frame has screwed beneath it a piece of 1-in. by 4½-in. board in which has been cut a circular hole to fit tightly on the post at the proper height, 11 in. from the top. The frame is secured to the post also by two brackets cut out of 1½-in. timber; these butt against the post and are screwed to it, being

screwed to the board at the top end. Nine inches or so below the roof-frame is attached the platform on which the birds' food is placed. This is made of good sound 1-in. tongued-and-grooved boards, made up square, secured by battens beneath, and then cut to a circle of 18 in. diameter. A scroll saw is used for this job. The battens must be placed so that they will clear the post, for which a hole has to be cut or bored. The table is slipped on to the pole—before the roof is fixed—held



WORKING DRAWINGS FOR BIRD-FEEDING TABLE

temporarily at the right location by a couple of nails beneath, and secured by four wooden brackets, cut like those for the roof-frame. Two of these, that will rest on the battens, must be cut shorter in consequence.

The holes to take the post can be bored with an expanding bit, if the handyman possesses or thinks it worth while to buy one. Bore through from both faces of the work, so that the job is not marred by the bit breaking through and splintering the wood. Use the ratchet action, if the brace has one, and clamp the work tightly to a piece of waste wood on the bench. Take short cuts and do not force the bit.

The roof is made up of an underframe of $1\frac{1}{2}$-in. by $1\frac{1}{2}$-in.

wood, from which rise two or three rafters at each side. These are notched to the lengthwise members of the frame and nailed to the ridge-board, which of course they meet at an angle. At each gable a post goes up from the frame to the underside of ridge-board at the intersection of the rafters with the latter. It is butted at top, notched to the board, and nailed; at the lower end it can be tenoned into underframe or merely butted. The curved brackets are cut from 1-in.-thick board and are butted and nailed to rafter and horizontal. The ridge is of ¾-in. board 4½ in. wide. Beneath the frame is screwed the 1-in. board which embraces the pole. Dimensions of these parts are indicated in the diagrams. The weatherboard of the roof should project 2½ in. or so beyond the rafters lengthwise, so that the roof at the eaves measures 1 ft. 8 in. square.

The ridge is finished off with a capping of sheet zinc. This is cut off to the actual length, plus 2 in., and wide enough to fold down over the ridge and extend some way over the top weatherboard. Its purpose is to exclude the wet. Creosote all parts but the actual feeding table. Butt of post should be tarred if convenient, or at least given two coats of creosote. When setting the post it will be an advantage to fill in 7 or 8 in. of concrete which, when set hard, will hold the post securely. Ram in the concrete while a helper holds the post steady. Do not disturb post until concrete is hard, when earth may be filled in and turf laid. The post should be erected after cleaning and shaping, and the roof and table fixed afterwards.

When assembling the job, slip on the feeding-table and fix the brackets, then put on the roof, bringing it down until notched end of pole top fits on ridge-board. If necessary the top must be trimmed or notch-eased until a snug fit is attained. Do not make notch too deep at first cutting. See that roof is square and level on pole; then drive a nail through board into pole on each side at the circular hole. Next attach and fix the two brackets to board and pole. This completes the structure.

BOOKCASES AND SHELVES.—A recess between chimney-breast and wall can usefully and conveniently be filled with bookshelves. The skirting-board and picture-

rail would prevent a standing bookcase or set of shelves from fitting close to the wall, but this can be overcome when building in shelves.

Let us suppose that the height from top of skirting to lower edge of the picture-moulding is 6 ft. and that the recess from wall to wall is 3 ft. wide. We shall need two boards 6 ft. 6 in. by $1\frac{1}{4}$ in. by 9 in. for the sides of the shelves, and eight pieces of 1 in. by 9 in. for the plinth, shelves and cornice. The side boards are carefully measured and scribed into the moulding of skirting and rail, so that they fit tight to these and to the wall. They will be secured by screwing to plugs in the wall, but this is not arranged till they have been marked out and prepared for the shelves.

The shelves can be housed in uprights, or adjustable ones can be had if desired; by using slotted steel strips and movable studs to support the shelves. Supposing that the former plan is chosen, the uprights, after scribing and fitting to wall, are taken down, laid side by side on the bench, and marked at intervals where the shelves will come. A groove $\frac{3}{8}$ in. deep is then worked across the boards, into which the shelf can fit. The groove is marked out across uprights with a scriber and straight-edge, and the depth with a marking-gauge on each edge of the board. It is sawn with a tenon-saw at each side and the waste wood removed with a chisel of the requisite size. Take care to cut no deeper than is needed, and to avoid making the groove too wide. In a housed joint of this description the whole success depends on a tight fit between shelves and sides. The shelves must be cut dead square and long enough just to fit tightly between sides.

Holes are now bored for screws to hold the uprights to wall, the uprights tried in place, and a couple of shelves tapped in gently to hold the job firm when marking it. With a bradawl mark the wall through holes in uprights, remove the latter and plug the wall where indicated. Metal or fibre expanding plugs can be used, and $2\frac{1}{4}$-in. iron screws, size 8. Plugging needs to be done accurately, and the holes must not be too loose. Hold the jumper firmly when drilling the holes and rotate it without letting it move from side to side. Screw-holes in uprights are to be countersunk so that head of screw lies below surface.

Now screw up the sides to wall, and tap in the shelves. A plinth can be fitted in front of lowest shelf, and a piece of 2- or 2½-in. stuff fastened to the uppermost one to take a cornice moulding, level with the adjacent picture-rail.

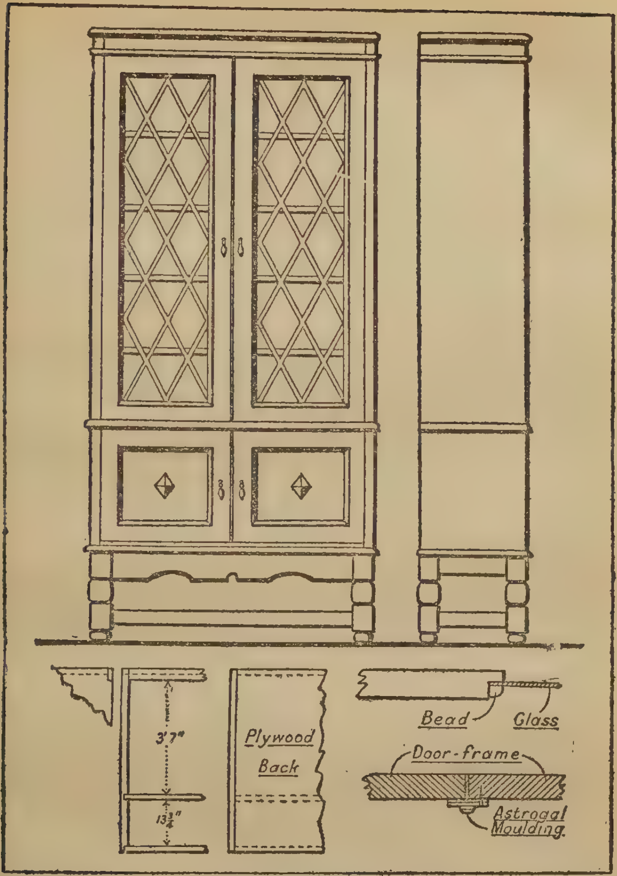
Standing Bookcase.—This is a job for the novice. A bookcase to stand in a recess is a useful and desirable piece of furniture for the handyman to construct, and the work involved is not too difficult. It is mainly a matter of careful and accurate marking-out, and of the proper jointing of the various components.

The diagrams and perspective drawing illustrate a bookcase with a handy cupboard beneath. It stands 5 ft. 11 in. high and is 2 ft. 6 in. wide. The width can be modified to suit that of any recess the article is intended for. The cupboard portion is 13¾ in. high, and the glazed upper part 3 ft. 7 in. The stand is 9¾ in. high, and the treatment of this part can be varied to suit the style of other furniture in the room. Suitable dwarf legs, turned or twisted, can be bought in sets from many local turnery shops, which also supply other such components as moulding.

Oak is the wood recommended for the job; it is easily obtained in fair condition and is not expensive. It may be stained and polished or varnished, or one of the new light finishes can be used. The sides are 11¾ in. wide; the stand projects a little beyond this, being 1 ft. by 2 ft. 6 in. Good, sound, and well-seasoned ¾-in. oak is used for the majority of the carcass. The top and bottom of the latter are rebated into the ends of the sides, and the back is rebated to the back edges of the sides. The back is made of stout plywood, and the top and bottom also may be made of laminated wood; in the latter case it must be at least ⅝ in. thick.

In addition to rebating the ends, the two sides must be grooved to take the oak board that forms the floor of the glazed portion, which is housed in. This and the top and bottom will be of the same length and can be marked and sawn off together. The top and bottom are glued, and nailed through the sides with oval wire nails carefully punched in. Next the partition between cupboard and bookshelf is tapped in and nailed.

The top board stands in from the back edge of the sides to the thickness of the plywood back. It stands



DIAGRAMS AND FRONT AND SIDE VIEWS OF STANDING BOOKCASE

in from the face or front edge to the thickness of the frieze rail ($\frac{7}{8}$ in.). Therefore the rebate in the top edge of sides must stop $\frac{7}{8}$ in. from the front edge. The rail itself is $2\frac{3}{4}$ in. wide and may be dowelled to sides, or merely

butted to them and nailed with oval wire nails. It is nailed also to the front edge of top board, against which it rests. The bottom board is flush with sides at the front and stands in from the back edge to take the plywood back. The partition board is flush at the front and stands in at the back, similarly, to the thickness of plywood back. The latter can be cut from a sheet to the full size, squared off, but is sure to need more or less easing to fit it to rebate, since the carcass is hardly likely to be dead square.

If the back is too tight a fit it may warp later, so this must be borne in mind. It is tacked to rebate with fine nails, and screwed to top and bottom boards and the partition board.

The easiest way to deal with the shelves is to screw on neat fillets to the sides for them to rest upon. Another and far preferable method—housing—we have already described; of course this must be arranged before assembling the carcass, and the sides grooved as necessary. Note that, unlike the bottom and partition boards, the shelves are not flush with front but stand in an inch behind the door-frames. Edges of shelves may be rounded.

The Doors.—Door-frames may now be taken in hand. They are made up of $\frac{7}{8}$-in. by $1\frac{3}{4}$-in. oak, mortised and tenoned together. After fitting the rails to stiles they are taken apart and the rebate worked on the inner edge to take the glass. This rebate is open to the front of the door, and after the glass is laid in, a bead is pinned in all round to secure it. Before working the rebate on the actual frame, a trial may be made on an odd piece of the $\frac{7}{8}$-in. oak, cutting a rebate deep enough to take glass and the moulding, and allowing the latter to stand in just enough to show a line at the face. The moulding is what is known as a "quarter-round," and the name correctly describes it. The meeting stiles of the doors are not rebated into each other, as is often down in cabinet work, but the right-hand one has a piece of moulding (an astragal is generally used) tacked and glued to it so that half its width projects over the left-hand door.

Three pairs of brass hinges are needed to hang the glazed doors. In place of a plain top rail the doors may have a shaped one, which would greatly improve the

look of the bookcase. The glass may be decorated with lead strips cemented on, to give the appearance of leaded lights. All necessary materials can be had from most ironmonger shops. The process is simple, but a special cement is used and the few simple instructions must be followed exactly.

A lock is fitted to the right-hand door. It may be one of the sort that is screwed to the back of the stile, or a better class cabinet-lock that is let into the stile flush with back and edge. The keyhole is measured carefully for and marked on the stile; it is bored and then cut with a pad-saw. A brass liner is driven in flush to form a tight fit, after lock has been fixed and tried.

Cupboard.—The panelled doors of cupboard are made up similarly to the glazed ones, the rebate being worked after joints have been cut and the frames have been tried together. Panels are of oak-faced plywood, and are beaded-in in the same manner as the glass, the rebate being arranged of a suitable depth. An astragal is fixed to right-hand door, and a pair of hinges will complete the cupboard portion. A lock is fitted as for the glazed doors. The panels may be ornamented with a rosette or lozenge glued on; any turnery shop will have a selection of suitable ornaments. A bead is mitred round the partition between glazed doors and cupboard, and another at the lower edge of frieze rail, above the doors. These are glued and pinned. A bolder moulding goes at top of this rail to form a cornice. It is glued and pinned at lower edge and supported by glue blocks rubbed on behind, where it stands up above the rail.

Stand.—The legs are cut off nice and square at top to the proper height (9¾ in.) and mortised for the top, shaped, rails and the lower, plain, ones. The latter are cut from 1¼-in. by ⅞-in. stuff, and the former from 1¾ in. or 2 in., according to the shape decided upon. Top rails are flush with top of legs. The joints must be accurate and fit tightly. When all is ready the components are glued up and assembled. Tap in the short rails to connect the legs in pairs, and give each pair a preliminary squeeze with a sash-cramp. Next connect the pairs by fixing the long rails at front and back. Try for squareness with a carpenter's square and, if all is correct, cramp up and place the stand in a warm room until glue has set.

When the stand is ready the bookcase may be fixed upon it. Stand it up square and plumb and drive a $2\frac{1}{2}$-in. nail down through bottom board into leg at each corner. Then rub on a number of glue blocks in the angle between rails and under side of bottom board. If in doubt about the position of these the handyman can examine any similar piece of furniture. Take care that the bookcase is left undisturbed until glue is hard. All that now remains to be done is to fix the moulding that is mitred round the top of the stand; it is pinned to the front edge of bottom board and to the sides of bookcase. Punch in all nails and fill holes with plastic wood, choosing a colour to suit the finish that has been decided upon. Rub down with sand-paper and the bookcase is ready for staining.

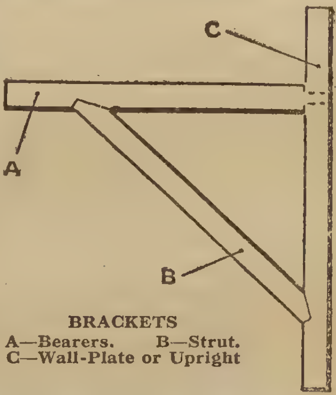
The easier rather than the conventional ways have been chosen for doing this job. When the worker has more experience he can use dovetail joints for carcass work and need not adopt the practice of butting and nailing, which is heresy to the "pukka" cabinet-maker. If a reasonable amount of care has been taken with the job, it need not be distinguishable from a factory-made article. The practice afforded in its construction will be very helpful to the worker, and his success in this effort will encourage him to attempt something more ambitious.

BRACKETS.—Japanned pressed-steel brackets are useful for fixing up shelving. They may be screwed to a wall after it has been plugged, or wooden battens may first be screwed to the wall vertically and the brackets fixed to the battens. In using the first method a difficulty is sometimes experienced when screwing to the expanding metal or fibre plugs: unless the screws are threaded almost up to the head they are difficult to screw up tight. When the threaded part has been screwed entirely into the plug it fails to penetrate any farther, and continued use of a screw-driver merely turns and loosens the plug itself. The remedy is, when using such plugs for fixing wall-plates, brackets, or such relatively thin metal parts, to employ special screws that are cut with a long thread that reaches to the head.

In fixing shelf brackets, screw up the end one and put a single screw into the next. A piece of batten can be laid across to check the level before finally fixing the second

bracket. In spite of careful marking with a straight-edge or a chalk line, the brackets may require to be a little higher or lower. A spirit-level placed on the batten will soon show if any alteration is necessary. If the help of another person is available, the second bracket may merely be held in place, with the batten resting on it, and moved up or down until the bubble of the level is central. Then the holes for screws can be marked through the bracket with a bradawl.

For wide shelves it is sometimes convenient to make up what are termed "gallows brackets," of wood. If carefully made a bracket of this description is very strong indeed. Its construction is clearly shown in the diagram. The wall-plate, or upright, C, is mortised to take the tenon of the bearer, A, which is wedged from the back. The strut, B, is notched into the upright and bearer in the manner indicated, and supports the latter. It is fixed by screws. Mark off the shape of strut with a bevel-square, or use the hinge joint of a two-foot rule. The bearer and strut are marked to the same bevel. The ends of strut and the notches are cut with a tenon-saw, taking care not to saw the strut too short.



BRACKETS
A—Bearers. B—Strut.
C—Wall-Plate or Upright

The bracket is secured to the wall by wooden plugs. Holes for these are made with an iron jumper or a plugging chisel.

BROODER, HOW TO MAKE.—In building a small brooder house, certain essentials should be borne in mind. A good, sound floor, free from draught, kept off the earth; plenty of direct sunlight for the health of the chicks; variable ventilation to suit all temperatures; protection in case of foul weather; and ease of cleansing and disinfection. The brooder described hereafter conforms to these requirements

A convenient size for the small poultryman has a floor area of 6 ft. by 4 ft. and the following method of construction will be found exceedingly simple and expeditious. For the main framework, clean, planed deal quartering, 2 in. by 2 in., is used.

First, for the front of the brooder cut two uprights each 4 ft. 6 in. long, and two cross-pieces 6 ft. long. Halved joints and modifications are specified in all cases as being simple for the worker and sufficiently effective for this kind of work, if accurately cut and well nailed home.

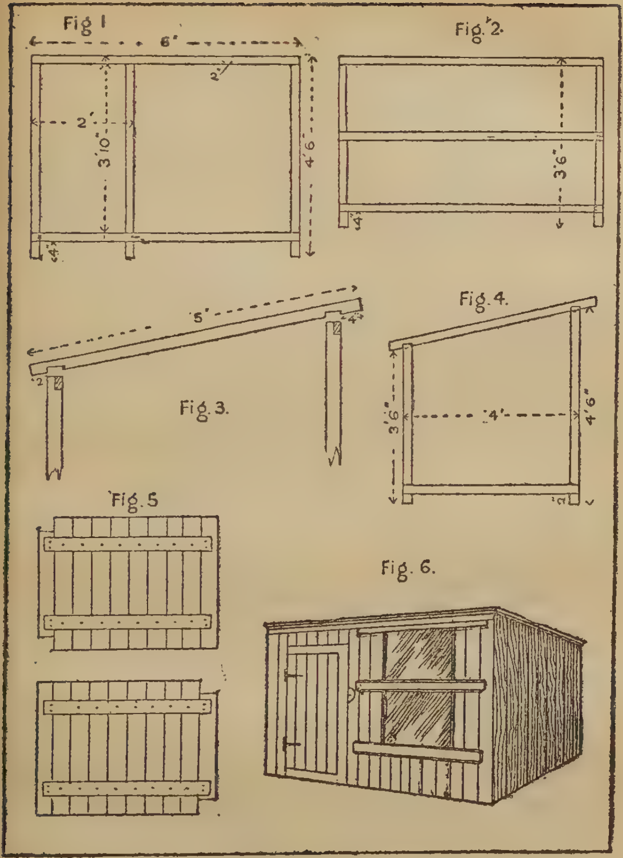
Make saw-cuts 1 in. deep at 4 in. and 6 in. from the bottom of the uprights, and chisel out the intervening wood to receive the ends of the bottom cross-piece, which has also been halved at each end. Test for squareness and nail together. A further 2-in. by 2-in. upright is inserted 2 ft. from the left-hand side by the same method, and the main framework of the front is now complete (Fig. 1).

For the back a similar rectangular framework is made, only that the uprights are 1 ft. shorter and a cross-piece, 2 in. by 1½ in., is run across the centre of the back. This is halved into the back of the back frame, thus leaving a flush surface outside to take the matchboarding (Fig. 2).

Before boarding the back frame make certain that the frame is perfectly rectangular. Then nail on matchboards vertically, flush with top and bottom; leave a generous ¾ in. overlapping at the sides, so that when the sides are later boarded the corners will be flush and weatherproofed.

Next, connect with front and back frames. Before doing so set the frames upright 4 ft. apart and temporarily tack pieces of batten lightly on to the sides to ensure that the frames are the proper distance apart and are vertical.

Then, holding a 5-ft. length of 2 in. by 1 in. against the sides of the uprights, mark off the proper angle for the cross-piece or rafter and cut carefully inside the pencil mark to ensure a good joint and a tight fit. A 5-ft. length of quartering will allow an overlap of about 4 in. at front and 2 in. at back, as shown (Fig. 3). The framework is completed by two stretchers, 2 in. by 2 in., halved into the sides, their lower ends 2 in. above the



DETAILS OF SMALL BROODER HOUSE

ground. To stiffen the framing and help support the floor, another cross rail may be fixed beneath front and back rails midway in the length. The side elevation of the frame is then as shown in Fig. 4.

The sides may now be covered with vertical match-

boarding, beginning at the back. Do not go quite up to the front uprights: a little filling has yet to be done to the front. Again test for absolute squareness of corners on the ground plan. We have next to fit in the floor, which will fix the shape of the house for good.

The floor may most simply be made by nailing $\frac{3}{4}$-in. matchboarding across the bottom stretchers from front to rear. On the other hand, in case of infestation or other contamination it is very useful to be able to remove the floor for disinfecting purposes. So in this case two panels of matchboarding (Fig. 5), each 4 ft. by 3 ft., are nailed on to battens whose outside edges extend to within 2 in. of the outside. Corners must be cut to fit snugly round the front and rear uprights. The battens are nailed on the beaded side of the matchboard so that a smooth surface is presented above when the battens are in position underneath. With a little fitting the floor will drop snugly into place and may be kept in position by a wire nail at each corner to prevent warping.

If the scheme of a loose floor is adopted, it is essential to run an extra stretcher across the middle of the house, as suggested above. It will check any draught at the division. This rail is halved into the lower rails, and the adjacent ends of the battens will have to be cut back at this point.

The fitting of the front may now be undertaken. At 1 ft. from ground-level insert a cross-piece between the centre and right uprights; another 18 in. above it, and another 18 in. above that again. These mark the heights of the windows.

Nail matchboarding vertically 1 ft. from the right-hand side and 1 ft. from centre post towards the right, leaving 1 in. of the centre post clear for the door. This will leave a space about 2 ft. wide for the windows. On the inside of the house attach wire-netting of $1\frac{1}{2}$-in. mesh to cover this space.

The door, a ledged and braced one, will be about 4 ft. high, 2 ft. 1 in. wide. It will be hinged to the corner-post, and will overlap the centre post by 1 in. and the top and bottom cross-pieces by 1 in. For hints on its construction *see* the article DOORS. Cover the opening underneath the door with horizontal boards between left-hand and middle post.

Adjustable ventilation is provided by six 1-in. holes bored 2 in. apart in the top of the door. They can be opened and closed by means of a simple shutter, also bored with 1-in. holes, 2 in. apart, which slides in two grooves. A similar ventilator can be made at the back.

For the window-frames, a convenient material is 1-in. picture-moulding of square section. Alternatively the rebate can be worked in the solid on some 1-in. by 1-in. deal. The corners need not be mitred, but can be joined with the usual halved joint. The glass is inserted on a thin bed of putty; a few brads hold it in place, and the whole is then puttied round in the same way as a window (*see* GLASS AND GLAZING, page 43). Good thick window-glass is desirable; "vita glass," if means allow of its use.

The window-frames can either slide between stout grooved runners nailed across the matchboarding or can be hung on butt hinges from horizontal pieces of quartering fixed to the front. It is most desirable that the windows should fit snugly and allow no draught when closed. For this purpose make them full 4 in. wider than the opening they are to screen.

Sheets of glass without framing might be used for the screens, in which case the groove in the runners will be very much narrower. There is always the danger of cut fingers, however, and the time and expense of framing is justified in the end.

The roof of matchboarding is finally nailed on crosswise, overlapping the front 4 in. and the back 2 in. The whole shed is then given a heavy coat of a mixture of creosote (three parts) and tar (one part). Roofing felt is nailed on with flat-headed felting nails and, to prevent the wind getting under it, four battens are nailed on over all.

CABINET MAKING.—When the novice has made some progress at simple carpentry and is able to use a few tools with accuracy and ease, he may attempt some of the less difficult jobs in furniture making and cabinet work. Instructions and diagrams are given elsewhere in this volume for constructing various useful articles, that even a beginner can tackle with fair prospects of success. A bedstead or a dinner-wagon, an ornamental table, and such pieces of furniture are good things to take in hand for a first essay at constructional woodwork.

Later on, the home mechanic could make a glazed book-case or a hall-stand, perhaps, while among smaller jobs might come a medicine chest or a book-trough.

Inability to execute more difficult parts of the work can be overcome by purchasing sets of components ready to put together, and this is quite a good way of beginning cabinet work. There are one or two firms that sell such parcels of parts, and even such an article as a dining-chair or a draw-leaf table can be made in this way from components. The joints are cut and sometimes other work difficult for the novice is done. Then for the man who is able to do more for himself there are aids like turned or carved sets of legs for tables or cabinets, grooved door-frame moulding to work with prepared rails having a grooved edge and tenoned ends, and so on. Table tops, the fall-flap for a bureau, and ready-framed cabinet doors are often useful parts that the amateur can purchase. All work at a craft is a means of self-expression, and we think it is worth while to point out to the novice how he can gratify his desire to create something, and turn out useful articles from the beginning, though he has few facilities and lacks experience.

Purists might think it better for the tyro to refrain from constructive attempts until he had spent a winter at less useful "practice" jobs and had learnt to do without such adventitious aids as partly prepared sets of components. We may point out that the model engineer makes use of sets of parts and castings, often machined and drilled, and has done so for years. Why should not his brother of the woodworking craft employ similar helps?

Tools.—In addition to the tools needed for simple carpentry, the amateur cabinet maker should procure the following: A tenon saw, 12 in.; panel saw, 24 in.; iron smoothing plane, 9 or 10 in.; bull-nose rebate plane; a couple of wood rasps; mitre box and shooting board; mortise gauge; 4-ft. sash cramp. A proper bench or a stout and firm table is absolutely necessary, and the worker must have a place where he can lay aside glued-up frames or like parts until safe to handle. Then, too, when only odd hours are available to put in at his hobby, he will make fuller use of the time if work in progress can safely be left on a bench from one day to another,

without the need for putting away tools and clearing away materials. So the handyman must arrange for a room where he can carry on undisturbed and leave his partly finished work free of interference.

A good glue-pot—by which is meant a large enough one of proper construction—and adequate means for heating it are a prime necessity. Though prepared glue has many uses in amateur woodwork, the beginner especially will find that the older method of dissolving Scotch glue in a little water and applying it hot has advantages that compel its use in really practical work. The glue-pot can be heated up and kept hot on a gas-ring or a small oil-stove. Many people put up with a makeshift pot formed from an empty treacle tin in an old saucepan, but this is a nuisance, and a proper pot costs so little that a substitute is not worth the trouble. In a workshed the lamp and glue-pot could be supported on a shelf or small bracket at a convenient height, covered and backed with a piece of tin-plate.

A quick-grip woodworker's vice on the bench cheek, a bench stop and a hold-fast cramp are necessary. In order to support the end of long boards or rails when in the vice, dowel-rod pegs may be inserted in holes bored in the bench cheek. These holes are in a line at such a height that the lower edge of the board being planed, for instance, rests on pegs at the correct level.

Carcasses and Framework.—In constructing the carcass for a wardrobe, or the framework of a chest of drawers or dressing-table—to name jobs that are likely to be tackled by the amateur when he has "got his hand in"—there are certain main methods of jointing that must be mastered. Rails are fixed to posts and stiles by the mortise and tenon; the top front rail of a chest of drawers or of a dressing-table would be secured at its ends by a single dovetail to the top of legs. Bearer rails are fixed by a mortise and tenon. The drawers of such a piece of furniture are made by dovetailing front and back to the sides. At the front a lap dovetail is used, that does not show on face; at the back, where a hidden joint is not desired, a common box dovetail. The bottom of drawer slides into grooves in the sides and front; or may rest against a rebate worked in the edges of these parts and be secured by a slip fastened to them beneath. In

order to give a greater bearing surface the slips may be thicker, and be rebated on the upper side for the drawer bottom. When a softer wood is used for the sides of drawers, these slips are usually of oak. The top of a washstand is secured by rebated oak buttons that are screwed to the top and rest in a groove formed lengthwise in the rails and sides of framing. A plinth around the base of a wardrobe or dressing-table is often halved together.

There are simpler substitutes that are practicable for some of these joints. The drawer front can be lapped so that no join is visible at face of work; the back can fit in a housing made in the sides, dowelled or screwed butt joints will serve for certain other situations. The enthusiastic home-worker, though adopting these "counterfeits" as long as he is obliged, will discard them for properly made joints directly he has progressed in skill. Much information on cabinet work can be got from a close examination of pieces of good furniture in the home. We have found that many novices are diffident about using glue; they are suspicious of glue blocks or such aids, and are inclined to drive in a nail or a screw when this is quite unnecessary. The holding-power of a well-made glue joint is amazing, but its strength depends on a close contact between the two faces, which should be separated by only the thinnest possible layer of glue.

Finishing.—After a job has been put together it should be rubbed down and all blemishes removed or concealed. Plastic wood in the proper colour for the finished job should be used to fill up holes; it supersedes most of the old-fashioned fillers and stoppings most cabinet makers used to prepare for the purpose. It is hopeless, however, to attempt to make up for clumsy or careless work by a liberal use of this material.

The major operations in woodwork are dealt with elsewhere in separate entries; and further relevant information is given in numerous "how-to-make" articles, where particular difficulties are explained and detailed instructions provided for the novice.

CARPENTRY FOR THE HANDYMAN.—The commoner and most important wood-working operations, such as the making of joints, are treated elsewhere. Cabinet work is the making of fine furniture, and joinery describes the making of doors, windows, cupboards and

such like. Here it is proposed only to give a general account of the methods used in constructional woodwork, the tools employed and the timbers dealt with. Nowadays there is not the old-time distinction between the work of the carpenter and joiner—the former engaged on building construction, making floors, roofs, staircases, etc.; and the latter at his bench constructing doors, partitions or sashes, running mouldings and so on. Joinery-work to-day is made at the mill by machinery, and much comes to us from the great timber-producing countries; it is only the occasional job that is made up in the old way by hand.

The home-worker is concerned with the tools and implements he will need in making a shed, a gate, a poultry-house, a child's swing, or a bench, to name but a few of the jobs which the amateur carpenter can undertake. Though many of these jobs are described in other articles, there is useful general information that can be given here with advantage. The first consideration is a workshop of some kind where a bench can be set up and tools can be housed, accessible yet out of the way of youngsters. Probably the worker will have to make shift at first with the occasional use of the kitchen, on which table his first jobs will be done. In spring or summer time, much work can be done out of doors, a capital way of getting fresh air and manual exercise. One of the earliest jobs will probably be the building of a shed for himself to serve as a workshop.

A bench top can be rigged up to clamp to the kitchen table as described in the article on BENCH. This protects the table, but does not overcome other disadvantages, and a substantial work-bench, either fixed or portable, should be made at the first opportunity. The carpenter is happy in that he can himself supply many of his needs and make his task easier. Probably an early job will be a tool chest, in which there is a proper place for the major tools. Most sheds and outdoor workshops are too damp in our winter clime for the tools safely to be left out on clips or shelves, and the chest must be big enough to hold them all, leaving room for others one is sure to acquire later. For woodworking is a hobby that grows on one, and since expense is saved in doing jobs for the home, an extra tool now and again is a reasonable outlay.

Tools are advertised in sets, but it is better to buy them singly and when they are needed. The initial outlay is much less, of course, and it is just as well to learn by actual practice how to use a few properly before buying others. Cheap tools are usually disappointing, but this does not mean that there are not some we may quite well buy for a small outlay. Bradawls, gimlets and such small tools can quite well be got at the sixpenny stores; but when it comes to bits or drills, to say nothing of hammers, chisels, or screwdrivers, it is better to go to a tool-dealer's and pay a fair price for a worthy article. People who expect too much for their money have only themselves to blame for disappointment.

Edge tools of all sorts must be good-quality ones if we are to do good work. An extra shilling or two spent on a jack-plane or a smoothing plane will be compensated by extra value in the tool. Good chisels are not expensive—in fact one of the most pleasant things about woodworking is the cheapness of fine tools—and we can get the best productions of Sheffield without "paying through the nose" for them. Marking gauges are turned out in very cheap grades, and it is as well to pick out something a bit better. The try-square will merit an outlay of half a crown or a little more, though one of sorts can be got for a shilling. The folding two-foot rule costs a couple of shillings, and a steel one folding to one foot is very useful for rough outdoor jobs.

A largish pair of pincers is advisable, and here there are good grounds for spending an extra sixpence or so. Pliers will cost up to two shillings if of British make and reliable. Those with side cutters for wire are useful. Do not buy the so-called "insulated" ones, or perhaps when holding a "sweating" job near the blow-lamp flame or over a gas-ring the sleeving of the handle may take fire. Coming to saws, the beginner can get on for a long while with a 24-in. hand saw, which he will use mainly for cross-cutting. A 14-in. or 16-in. tenon saw for roughish outdoor jobs and another—12 in.—of better grade to be kept solely for joinery are advisable. A set of compass saws and a universal handle are useful for curved work. A keyhole saw, handle and blades can be bought at any time when a job needs it.

We seem to reiterate this kind of remark, but when

buying saws, particularly, an extra shilling should not be grudged. Here, if anywhere, our advice is merited, for a poor saw is an abomination. The brace should be a ratchet one if the funds will run to it, but the beginner can get on with a plain brace. Purchase good-quality bits; others can be got as wanted, if we start off with four or five centre-bits and a couple of gimlet bits. Beware of cheap centre-bits! Twist or auger bits should be got to suit the job in hand.

A set of two "expansive" or expanding bits is very handy for boring occasional large-diameter holes—up to about 3 in. can be done with the tool in soft wood. A hammer (Warrington pattern) and a joiner's mallet are necessities even for the beginner. A maul or heavy mallet can be improvised for outdoor work by cutting a cylindrical log of about 6 in. diameter, boring an inch-hole through it cross-wise, and fitting an ash handle or even a piece of broom stick.

A large try-square for outdoor use is described in the article on AVIARY; it is easily made and very handy in laying out foundations of a shed and in testing framing for square.

The most important joints we shall employ are the butt joint, lap joint, halved lap and the mortise and tenon. The latter joints in framing or in such a job as a gate are often pinned—a piece of dowel going through stile and rail or post and cross-bar at the joint. The halving joint is used at the intersection of two timbers, and at the angles for making up frames; and the butt joint is used for rough-and-ready work. Shelving is fixed to uprights by means of a housed joint.

Timber for our carpentry will probably be used mainly in outdoor jobs, and a few hints here will be of value. In a new home there will probably be the garden to lay out; borders to edge; arches or summer-houses to construct; and perhaps a swing for the kiddies. Garden edging can be formed of ¾-in. by 4½-in. rough boards, which may be bought for about four to five shillings per 100-ft. run. The same timber is useful for many jobs about the garden; the stakes for garden edging may be cut from the same stuff, or from 1½-in. by 1½-in. quartering. The latter will cost about six shillings per 100 ft. Prices vary in different districts, according to the distance

from the port of landing, but these we quote give an approximate idea of cost.

Deal in 2 in. by 2 in. costs round about 10/– to 11/– per 100 ft., and if planed another two shillings to half a crown per 100 ft. Planed or "prepared" timber should always be specified for good work, such as the framework of a shed or anything but the roughest or most temporary of erections. Matching, 6 in. wide by $\frac{5}{8}$ in. thick, can be purchased for 10/– or 11/– per 100-ft. run. Battens, 1 in. by 2 in., cost 8/– planed and 6/– rough; 1 in. by 3 in., 8/– unplaned, and 10/6 prepared. Stouter quarterings, 3 in. by 3 in., can be got for 18/– per 100-ft. run prepared and 3/– less if not planed. These are all timber-yard prices for not less than 100 ft. of a sort. The handyman must be prepared to pay a little more for broken quantities; and if he purchases lots from an ironmonger or oil and colour stores will find his stuff cost still more. The posts for a swing should not be less than 4 in. by 2 in. Material for such a job can be bought to bare requirements when the job is taken in hand.

When commencing operations it is best to take 100-ft. lots of useful stuff and keep a little on hand. The handyman's better half will find the offcuts handy for "kettle brackets" or kindling wood, which may the better persuade her to overlook the occasional sweeping up of chips and shavings which result from his activities. The timber can be kept on cross-bars that rest on the roof-plates of the shed; here it will be dry and out of the way until needed. The longer it is kept in this way the more seasoned it will be. As stacked in the timber-yard it does not get the airing it needs to fit it for good work; and any required for indoor jobs, especially, should certainly be given a further preliminary seasoning in the worker's shed. There are several good reasons, therefore, for keeping a little timber on hand.

Feather-edged boards—often called "weather-boarding"—are used for roofing; the usual size tapers from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. and is 6 in. wide, costing 7/– to 7/6 per 100-ft. run. Better grades are rebated, at the thick edge, so that they lie flat when fixed. A different sort of board, desirable for poultry-houses, summer-houses and ornamental work generally as a wall covering is

"matched"—i.e. tongued and grooved and moulded—weather-board. Flooring boards are sold in various thicknesses, and 6 in. by 1 in. thick costs 11/- per 100-ft. run. The wood is planed on one face and both edges, and comes in for many jobs besides flooring or decking a platform.

When making up a screen having panels filled in with trellis, specially prepared timber is obtainable which enables a neat and workmanlike job to be done with a minimum of labour. Posts, rails and capping are ready grooved to take the trellis, and the frame is jointed by cutting stub tenons in the rails to fit into grooves in posts; the capping again is fastened to posts at the top by similar tenons in the latter. The top of rails and capping is sloped or bevelled to throw off the rain. Stout V-jointed matching is used for outdoor work of this description.

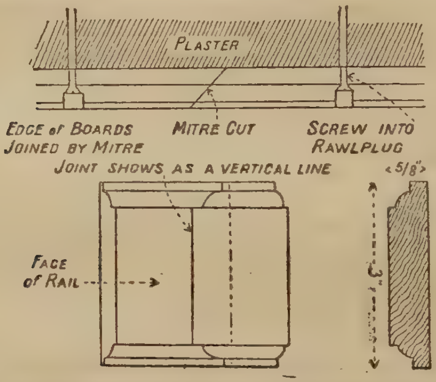
Laths for making up trellis should be good quality sawn ones, not the sort that are usually sold for partition work. Fencing is often made of posts, rails and capping, formed up in panels and filled in with rectangular open work resembling stout trellis. Inch by $\frac{1}{2}$-in. stuff is just crossed and nailed for this, or 1-in. by $\frac{3}{4}$-in. batten can be employed and the crossings neatly halved together for a worth-while job.

Many of our readers will be house-owners, to whom a durable result is the first requisite in outdoor carpentry. To such handymen we would say: Don't calculate the first cost only of a woodwork job, but take it over the period such a structure will endure. A light, cheap fence or screen that will rot or tumble down in a couple of years, or look disreputable and "tipsy" for another couple, is not worth the labour put into the job. Good materials cost so little extra, and the labour is much the same, or very little more, in putting up a sound job in proper style. An outhouse or shed that is advertised at a temptingly low price may look good and satisfying in the pictures, but prove very disappointing on receipt. How much better policy it is to spend the same amount on good materials, and use one's own labour! The finished job will be worth at least twice as much.

CHAIR RAIL, HOW TO FIX.—A broad wooden rail fixed to a plastered wall somewhat after the manner

of a picture rail, but at such a height that it will prevent the surface being marked by the backs of chairs when they are pushed against it, will be found a useful means of protecting decorations in a living-room, club-room or similar apartment.

The rail should be of deal or oak, ⅝ in. thick and about 3 in. in width. The two edges facing the room should be beaded or chamfered. Suitable mouldings can be bought at a timber-yard, but it is easy for the home-worker who has a beading plane to run the beads himself



JOINING A CHAIR RAIL IN THE STRAIGHT

on 3-in. by ⅝-in. planed deal. Allowance should be made, when measuring up, for waste in cutting, and for the turns around any chimney-breast or like projection, or into and out of recesses in the walls.

The ends of the rail should be mitred across the thickness of the wood to form a joint at corners. Screw-holes should be bored in pairs at intervals of 2 ft.

Use the stuff in as long pieces as possible, going completely along a plain wall. If you have to join in a straight run, cut the ends to opposite mitre bevels across the edge so that they will overlap when pressed up close. Make the joint at one of the studs. When nailed down with fine wire-nails the joint will hardly be seen. On a plugged wall such a joint would need screws in each of the lapping ends, 1½ in. away from the joint.

Mark the average height at which the chair backs touch the wall, get an assistant to hold the rail approximately in position and adjust it by means of a spirit-level. When it is perfectly level, mark the wall with a pencil line along the top of the rail, and also mark the centre of each screw-hole on the wall by means of a bradawl or a fine centre-punch held perfectly horizontal. You will have to get somebody to hold the rail steady when marking the holes, as it is important to indicate the exact position of each one. The holes should then be drilled in the wall with a small jumper, taking care that they penetrate the brick or a layer of mortar, if it is an outside wall; in the case of a partition wall of lath and plaster, it will be necessary to bore holes into the studding, or upright pieces of quartering that frame the wall. These pieces of studding are about 3 ft. apart, and start from either side of the door-frame, so it will be an easy matter to find them by pricking with a fine awl and measuring. Sometimes the studding can be located by the nail marks on the skirting boards showing where the latter are nailed to the studding. In any case, a little exploratory work with a bradawl just above the skirting, or in the part of the wall that is to be covered by the chair rail, will clear up any doubts regarding the whereabouts of the studding. Many houses built in recent years have partitions of breeze blocks, a material that is easy to deal with by plugging.

When the holes in the wall have been filled with wooden plugs—or, preferably, Rawlplugs—the rail should be screwed on evenly all round, taking care that no fragments of loose plaster are allowed to lodge between it and the wall. The screw holes should be deeply countersunk and concealed with putty or plastic wood, finished off level with the surface. The size of the screws used will depend upon the thickness of the rail and of the plaster; 1½ in. should be the minimum length.

The completed rail may be painted, or stained and varnished to match the existing woodwork. For a fine finish, it can receive two coats of flat oil paint and one coat of enamel.

CLOTHES AIRER.—A rack for drying and airing clothes is a great boon in every household, since it enables the housewife to be independent of vexatious weather

conditions in washing and drying the domestic linen. A rack that can be raised or lowered by means of a cord and pulleys can easily and cheaply be made at home.

The first thing to do is to settle where the rack is to hang. The usual place is the kitchen, where the airing of the linen is expedited by the currents of warm air that rise to the ceiling. A suitable position should then be chosen, bearing in mind that the rack, when draped with linen, should not obstruct the light from a window nor interfere with electric light fittings and the opening and closing of doors. Above all, if gas lighting is used, it must hang at such a distance from the jet that it is impossible for a draught to blow the linen against the burner.

The length of the rack must now be decided upon. In the interests of stability, this is to some extent governed by the distance between the two pulleys which support it. These pulleys are screwed into the joints of the floor above, and on no account should they be fixed merely into the lath and plaster of the ceiling. If both the pulleys are screwed into the same joist, they may be fixed at practically any distance apart that is convenient; but if they are suspended from two different joists, so that a line joining them would cross the joists at right-angles, it is obvious that the distance separating the pulleys is not so adaptable, and must depend upon and be a multiple of the distance between the centres of any two joists. The latter method has an advantage, however, in the fact that it is necessary to take up only one floor-board in the room above, instead of two, as the former case demands.

Having marked the approximate positions on the ceiling that the pulleys are to occupy, measurements should be taken from one of these points to the walls and transferred to the floor above, so as to indicate which board is to be taken up. When the latter has been removed, carefully bore with a fine bradawl through the plaster close up against the joist, so that its point projects through the ceiling below. The hole to receive the screw of the pulley should then be bored at a distance of half the thickness of the joist from the guide hole in the plaster, so that the screw lies exactly mid-way in the thickness of the joist, in order to ensure a good hold.

If the other pulley is to be screwed into the same joist, the proper distance should be marked off across the floor-boards and the indicated board taken up, when the pulley can be marked for and fixed as already described. If, however, the second pulley is to lie within the limits of the same floor-board as the first one, the required distance should be measured off across the tops of the exposed joists, and the nearest joist selected to receive the pulley. The pulley situated at the end at which the cord is to be

Fig 1

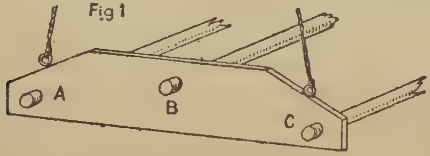
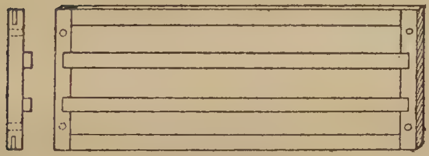


Fig 2



CLOTHES AIRER

manipulated for raising and lowering the rack should be double, i.e. with two sheaves; the other one should be single.

The rack itself can be of deal. The two ends should be sawn out of $\frac{3}{4}$-in. stuff to the shape shown in Fig. 1. Measurements, of course, can be varied to suit the amateur's requirements, but some suggested dimensions are shown. Holes are bored at A, B and C to receive the ends of the rods, which are formed from curtain pole of $1\frac{1}{8}$-in. diameter. Should this be unobtainable, we can use straight-grained quartering, rounded with a smoothing plane and glass-paper to the necessary diameter; 8 ft. will be found a useful length. If wooden curtain-pole stuff is used it must be plain, unvarnished or uncoloured. For a very short clothes airer, such as might be intended to fit into a kitchenette, ordinary

broom-sticks will be found suitable, if they are cut off square at the end. The poles should fit tightly, and be glued into the holes in the end pieces, and be further secured by long nails driven in from the edges. A pair of stout screw-eyes should then be attached to each end piece, as far apart as possible, or holes can be bored in the wood, through which the supporting cord is knotted.

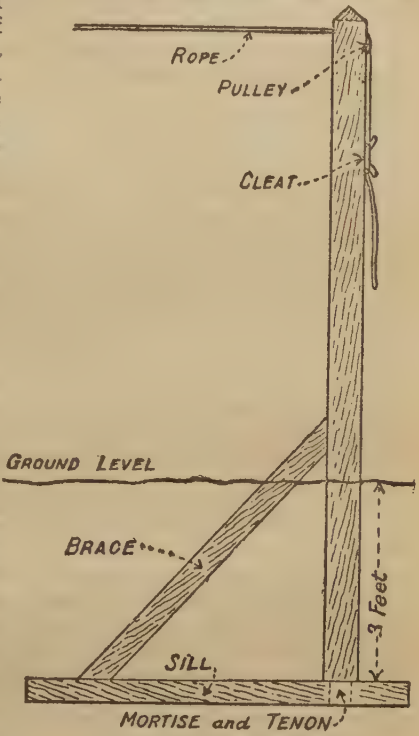
An airing rack upon somewhat simpler lines is shown in Fig. 2. Here the end pieces are merely strips of 1½-in. by 1½-in. wood, while the poles are replaced by rectangular battens; the latter should be notched into the end pieces on top. Drill a couple of holes in each end piece to receive the cord, as shown, and the airer is completed.

Cord and Pulleys.—To hang either of the racks, get the necessary amount of the best quality sash line—an 8-ft. rack will need about 10 yards, but the precise amount varies with the circumstances—and attach one end securely to the farther end piece of the rack. Pass the cord over the single pulley, along the ceiling, and over one of the sheaves of the double pulley; fasten it temporarily. The other end of the cord is now passed over the other sheave and fastened to the opposite end of the rack. By pulling on the free lengths of cord, adjust the rack until it is level; then make a knot in the double rope which will act as a stop and prevent it from going too far over the pulley. Several more knots should be made at intervals, and a cleat should be screwed to the wall, or to the door jamb or window-frame, to secure the end of the rope when the rack is in use.

CLOTHES-LINE POST.—There are few things more annoying than a clothes-line post which sways about insecurely with every gust of wind, or which refuses to allow the line to be drawn up tight without threatening to collapse and precipitate the clean linen on to the ground. Here is a method by which a post can be fixed immovably.

Since the post which we are going to describe is a permanent structure, intended to last for a long time without rotting, it should be made of timber that will withstand damp. Larch or oak will be found best for this purpose. It can, however, be made of yellow deal if the wood is well soaked in creosote or covered with tar below ground-level.

The upright post itself is 4 in. square. The lower end is mortised into another piece of wood about half as long and not quite so thick, though it should be about 1 in. or more wider. This wooden sill should project a few inches beyond the mortise on one side, while the other extremity is joined to the post itself by means of a strong wooden brace. This brace should be on the side facing the direction in which the pull of the line is exerted; and the upper end of the brace where it joins the post should project a few inches above ground-level. A mortise must be cut about 2 in. from the top of the post, to receive the pulley, which should be of brass in order to avoid staining the line with rust marks. The line will then pass down the back of the post and be fastened to a cleat which is screwed thereon. If preferred, however, a screw pulley may be screwed into the front of the post, in which case the line, after passing over the pulley, will come down the front of the post; but this latter method does not present so finished an appearance as the former.



CLOTHES-LINE POST

In order to protect the top of the post from the

weather, it may be fitted with a pyramidal cap of hardwood, or else with a piece of sheet zinc bent into the form of a ridged roof.

After having been thoroughly tarred or soaked in creosote, the bottom of the post, together with the sill and brace, should be buried in a 3-ft. deep trench and covered with large stones and broken bricks; the earth should then be filled in and well rammed down. A few inches of concrete rammed in first will make a much better job.

Portable Post.—When a clothes-line post is only used occasionally and its presence at other times in the garden is likely to offend the eye, a removable post should be fitted, with a special socket in the ground to receive it. The upright post itself can be similar to the one just described except that, in order to lighten it for lifting about, it should not be more than 3 in. square; the sill and brace will not be required, of course, their place being taken by an iron socket, or by the wooden socket we shall describe. The latter should be from 2–3 ft. deep, and should consist of 1-in. boards screwed together at the edges to form a sort of box which makes a loose but adequate fit with the bottom of the pole. The bottom of the socket consists of a stout, rectangular board projecting on either side, so as to form a substantial base, in a direction parallel with the pull of the clothes line. To offer greater resistance to this pull, a 1-in. by 6-in. board about 1 ft. in length can be nailed across the socket on the side facing the pull, and about 3 or 4 in. below the surface of the ground.

After being well soaked in creosote or anointed with hot tar, the socket should be inserted in the ground; let it stand up so that the top projects 2–3 in. above the surface, in order to keep it free of obstructions. For the same reason, the opening should be kept closed when not in use by means of a hardwood lid, working on a hinge and weighted underneath with a piece of sheet-lead to keep it shut.

CURTAIN POLES AND RODS.—Since the long muslin or lace curtains which used to drape our windows have passed almost completely out of fashion, the wooden or brass poles that supported them have been largely replaced by the light, pliable metal rail or the

familiar rustless wire spring curtain "rod." The older form of fitting, however, is still used for really heavy curtains, and a few hints on its construction and fixing may not be out of the way.

A wooden curtain pole is very simply and easily made. First obtain a sound piece of deal of the required length (remember it should be 6 or 7 in. longer than the overall width of the window-frame) and quite square in cross-section. Ordinary deal quartering, sawn as required, is quite suitable. The wood should be perfectly straight and free from knots. The usual thickness varies between 1¼ in. and 2¼ in. It will depend on the length of the span and the weight of the curtains which it is intended to support. Brackets and rings should be obtained first, and the pole made to suit them.

Now plane off lengthwise the four sharp edges or arrises, thus reducing the wood to an octagonal form. The eight arrises thus formed should be again planed down, giving rise to sixteen; and the operation should be repeated with the smoothing plane, taking off very fine strips of wood until the pole is approximately round in section. It should then be finished off quite round and smooth with glasspaper. The pole should afterwards be french polished or treated with a hard cellulose enamel, affording a surface which will present the minimum amount of friction to the passage of the curtain rings. Ordinary paint and varnish should be avoided, if possible. Light curtain rods are supported by brass brackets secured to the outer part of the moulding round the window frame. Larger poles rest in brackets screwed to plugs in the wall, and long poles should also have a bracket midway. The curtain rings should not be too small, or difficulty will be experienced in drawing the curtains, and they should be as light as possible. The extreme outer ring on each side should be slipped outside the bracket, so as to anchor the end of the curtain. The ends of the pole may be finished off with turned ornaments of wood or metal.

If the pole is to fit a bay or bowed window, the sections must be jointed; or else the pole must be mitred in several sections, so as to fit the contour of the window with great accuracy. In the latter case each joint must be secured with a long steel screw whose head is deeply recessed

into the wood, the hole being afterwards stopped with putty. Jointed poles will require the support of additional brackets.

Brass curtain rods and poles can be cut with a hacksaw or saw-file. In the latter case, a series of fairly deep cuts is made with the edge of the file all the way round the rod, which will then be found to yield readily if sharply bent. Metal poles can be joined at corners by means of special flexible elbow joints, which can be made to assume any angle desired.

Rails and Runways.—The fitting of a curtain support of the pliable metal rail type should present no great difficulty to the amateur. A typical variety consists of a soft brass rail whose cross section resembles an inverted T. This rail is pierced at regular intervals with holes through which pass long screws for attaching the rail to the moulding at the top of the window. Over the shank of each screw fits a long collar, or spacer, which keeps the rail at a uniform distance from the woodwork. The runners to which the curtain is attached slide along the projecting flange of the shaped rail. Each runner consists of a pair of small rollers joined by a U-shaped hoop, to which the usual brass curtain-hook is attached.

The rollers, having bevelled rims and lubricated bearings, slide along the rail with a minimum amount of friction, enabling the heaviest of curtains to be moved with a light pull. Good quality fittings should be bought, they are cheapest in the long run. If it is desired that two curtains should overlap slightly where they meet, they should be hung on separate overlapping rails, one of which has its end bent, or cranked a little forward, so as to project beyond the other.

If desired, curtains can be closed or opened merely by pulling cords at the side of the window-frame, which is certainly a preferable arrangement, save in the case of the heaviest types of curtains. The cords for drawing the curtains apart should pass over pulleys at the upper corner of the window-frame and hang down at, let us suppose, the right-hand side of the window. One cord is then threaded through the rings of the right-hand curtain, being securely fastened to the extreme inside ring. The other cord passes right through the rings of both curtains and returns over a pulley placed at the

left-hand upper corner of the window-frame, to the extreme inside ring of the left-hand curtain, to which it is fastened. A pull on both cords together will then draw back both curtains simultaneously, while each of them can also be adjusted independently by means of its own cord. A somewhat similar arrangement of cords and pulleys serves to draw the curtains apart, the ends of the cords being located, in this case, at the opposite side of the window.

The light, lacquered brass rods used for hanging casement curtains or the type of net curtains that fit on the window-sash, are easily dealt with. They are usually bought by the foot and can be easily cut with a file or hacksaw. The brass clips for supporting them are too familiar to call for special mention.

Spring Wire "Rods."—Of recent years a flexible "rod" in the form of a strong, rustless, special spring has come greatly into favour. This is stretched across the window and held fast by a hook at either end. These rods are obtainable by the yard, or made up with eyes in various lengths. When purchasing or fixing them it should be borne in mind that the unstretched spring should be only about three-quarters as long as the space to be spanned, so that when strained it will be taut enough to prevent sagging. If need be, however, these springs can easily be reduced in length, all that is necessary being to unscrew the hook at one end with a pair of pliers, cut off the superfluous length and re-screw the hook into the new end. To avoid sagging when the curtains are drawn, should the space to be spanned be very long, it is well to screw in a hook at the centre of the window and allow the rod to lie in this.

Similar springs may also be used to support the valances that drape the sides of bedsteads. In the case of wooden beds, eyes may be screwed into the posts at head and foot; if the bedstead is of metal, the spring should be twisted round the posts at each end and then hooked upon itself, or it may be fixed with copper wire loops.

DINNER-WAGON.—A service wagon is a welcome piece of furniture in any home and saves much running to and fro between kitchen and dining-room. The wagon shown in Fig. 1 is one of the easiest of jobs for

the amateur, and only one type of joint is called for—a bare-faced mortise and tenon.

The legs are cut from oak $1\frac{3}{8}$ in. square, and the rails from $1\frac{1}{2}$-in. by $\frac{5}{8}$-in. stuff (Fig. 2). As the diagrams show, the front rails come lower than those at back and sides, since the tray bottom rests upon the upper edge of the front, and is fastened to the lower edge of the other rails.

The ends should be jointed and put together first. The mortises for back and adjacent side rails are cut through to meet, and the tenons are mitred. Since the

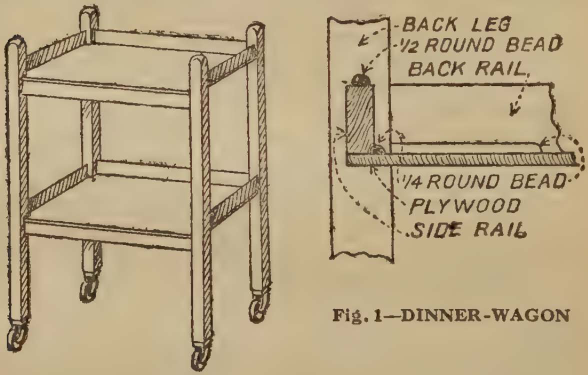


Fig. 1—DINNER-WAGON

mortises for front rails come lower than those for sides, this device is not needed here. We termed this a simple job, but what work there is must be done with accuracy or the wagon will be a failure. The bare-faced tenons are easy to cut and should give no trouble; dead square shoulders must be formed. Select a mortise chisel of the size to suit tenon and see that the mortises are not made too big. Any carelessness in placing chisel or in holding it will result in untidy sockets that have to be cleaned up—a botched method that generally ends in mortises being too wide, presuming that the tenons were accurately cut. An accurate setting of the mortise-gauge points to the width of the chisel, and of the stock to the right distance from the edge of the rail or leg, should enable the marking to be done properly.

When the ends have been glued up and assembled

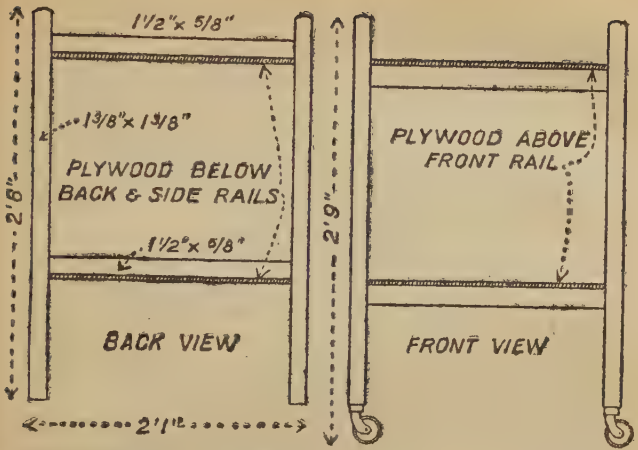
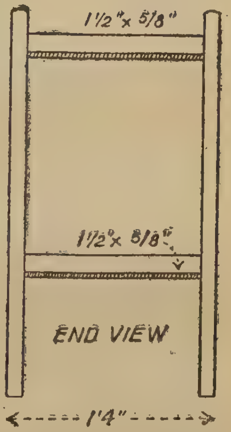


Fig. 2—WORKING DRAWINGS FOR DINNER-WAGON



cramp them up and set aside until fit to handle. The tray bottoms are cut from oak-faced plywood, and come out to the edge of the rails. They will need to be notched around the legs, and it is important to avoid removing too much material here. The plywood is glued, and fixed also by short pins or fine screws. The appearance of shelves can be improved by a quarter-round moulding fitted against rails at sides and back; it is butted against legs at the corners. Another embellishment might be a half-round embossed moulding glued and pinned to the top edge of all rails; at the front it comes on top of the plywood where it rests on rail.

The castors should be about 3-in. high over all. They should have rubber-tyred wheels of at least 2 in. diameter, these being necessary to enable the trolley

to ride easily over carpets. A more elaborate trolley can be constructed by using turned or twisted legs specially dimensioned for the purpose. These can be got with three squared portions, to allow for three shelves. The method of joining rails and legs is the same as in the wagon described above. A two-shelf wagon can be made up by using cabinet legs; these are tapered, turned or twisted for the bottom ten inches or so, the rest of the leg being rectangular in section.

The home worker can obtain sets of legs at some shops which sell fretwork accessories, where also he would probably find square-section oak and other wood in three-feet lengths, suitable for the plain legs of the wagon illustrated. Even if remote from a timber-yard or turnery shop, he can order many of his requirements by post from firms whose advertisements can be found in the woodworking or handicrafts journals.

DOG KENNEL.—If a dog, that is intended to be kept outdoors, is to be healthy and happy it must be housed in a rainproof erection standing on a dry floor off the ground and ventilated without direct draught. In case of parasitic or other infection it must be possible readily to open the kennel for disinfection and cleaning.

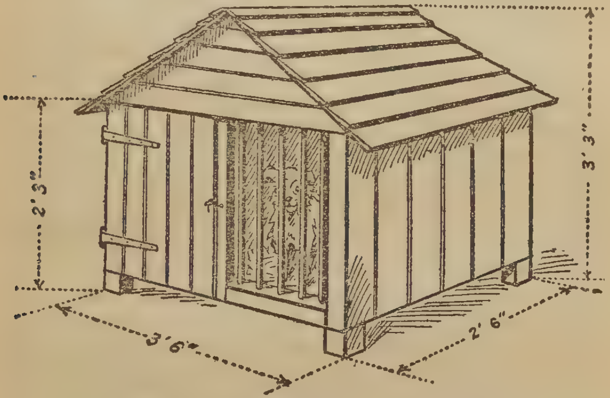
The size must of course depend on the breed of the dog, and in deciding the size a good rule is to allow 50 per cent. of headroom over and above the height of the dog when it is standing upright. The kennel whose description follows is designed for a terrier whose head is 18 in. from the ground; the eaves will therefore be 27 in. from the floor. The width is 3 ft. 6 in. and the depth 2 ft. 6 in., as shown in the diagram.

Four 2-in. by 2-in. corner posts are joined by four 2-in. by 1½-in. rails mortised or halved into them at 3 in. from the ground. Similarly, four rails are attached at the top. The edges of the rails are to be flush with the face of the posts.

The floor, of ¾-in. matching running from front to back, is to be nailed on to the lower rails; cut out corners for the posts, and see that the floor comes flush with the outside all round.

The roof should have a slope of at least 30°; the ridge will therefore be about 3 ft. 3 in. above floor-level. Four rafters of 2 in. by 1½ in. are cut to fit on to a ridge of 2-in.

by $1\frac{1}{2}$-in. stuff and to fit over the top rails. The rafters should each be 2 ft. 6 in. long, allowing about 6-in. overhang at the sides. A piece of 1-in. square stuff is let into the top front and back rails about 2 ft. 3 in. from the left-hand side and a fillet is nailed to the floor boards immediately beneath it; on to these a piece of stout three-ply is tacked to form the partition of the sleeping compartment, leaving an opening of 12 in. at the back for entrance. At this point a piece of 2 in. by $1\frac{1}{2}$ in. is



DIMENSIONS FOR MAKING DOG KENNEL

halved into the front of the lower and upper rails to act as a door stop, the 2-in. edge facing the front.

The sides can now be matchboarded, cutting the top boards to fit snugly under the rafters at each end and carrying the matching above the upper rail to the level of the top of the rafters, so that the matching of the roof will meet them. The back is to be matchboarded, overlapping the sides about $\frac{3}{4}$ in. so as to make a square corner. The triangular space between roof and the top rail requires to be neatly filled in. To make the kennel quite accessible (in case of disinfection or in case the dog refuses to come out) a door across the sleeping compartment will be found more convenient than a solid front. Matchboarding is nailed on to two horizontal battens whose outside edges fit exactly between top rail and the floor.

This door is hinged to the left-hand side with cross-garnet hinges, the straps being carefully bent in the vice at right-angles, and is secured to the upper and lower rails by sliding bolts. The door must fit quite snugly, or draught will come in just where it is not wanted. The other door of the kennel is hinged to the right-hand side of the structure in a similar manner. It is not a solid door but a framework of (nominal) 1 in. by 1 in. halved at corners. The bars can be formed of ½-in.-thick laths let into slots cut in the framework at the back; or a neater method is to use motor-bicycle spokes inserted into the frame from the top at 4-in. intervals. If desired, a thin strip of wood can be tacked over their heads, but in practice this is not necessary if the lower holes are a tight fit and the bars are driven in.

It is assumed that the dog is allowed full range of the garden where the kennel is situated. If not, a run must be constructed of wire netting on 2-in. posts, tarred and driven into the ground with spur supports at each corner. The house should be well creosoted and the roof felted.

DOORS.—The home mechanic at some time or another may desire to make a simple door for a shed or outhouse. We here give instructions for making a strong "ledged and braced" door that will meet his requirements in such cases. In this type there is no framework to the door itself, and the matched boards of which it is made are held together at the back by ledges, horizontal cross-pieces screwed to the boards and to which the latter are nailed. On examining a door of this description it will be seen that the ledges are connected by a diagonal of similar stuff—the brace—whose purpose is to stiffen and support the boards. When properly fitted, the brace is notched into the ledges at top and bottom in such a way that it prevents sagging at the point where it is most likely to occur—the top outer edge of the door.

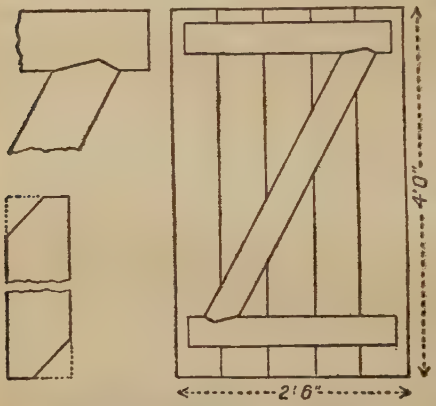
In many doors that one sees, the brace is merely butted against the ledges, and loses much of its value in consequence. It should run diagonally upwards and outwards, from the hanging edge to the locking edge and be properly notched into the ledges to take the thrust: light doors need only two ledges, but stouter ones should have three ledges and two braces. The boards are nailed through to the diagonal, from the face. Upon examining our

diagram it will be seen that for part of the width the end of the brace is cut at right angles, both top and bottom, and that this right-angled portion fits against a similarly shaped face of the notch in ledges. The remainder of the end of brace is cut back and slopes towards the opposite side. The hinges are of the sort known as cross-garnets, and the straps come over the top and bottom ledges, being screwed on to face of door in this position. A Yorkshire latch or some other simple fastening is usually fitted to this kind of door, and it may be further secured by a couple of bolts.

Door for Coal Bunker.—We give a diagram of a ledged and braced door suitable for a coal bunker or similar structure. It is 2 ft. 6 in. wide by 4 ft. high, with a ledge at top and bottom and a single brace. V-jointed matched boards $\frac{5}{8}$ in. or $\frac{7}{8}$ in. thick should be used, and the brace and ledges ought to be of $\frac{3}{4}$-in. stuff about $4\frac{1}{2}$ in. wide. If the woodwork is to be painted, this should be done after the boards have been cut and tried together, when at least one coat should be applied to the edges and those parts that will be covered by the ledges and the diagonal. The under side of these members should be painted at the same time as the boards. When the paint is dry the boards can be put together again—the outside ones will have had the tongue or groove removed, as the case may be, on the outer edge—and the ledges screwed to the first board. Arrange some cramping device so that the boards can be forced together and close joints obtained, and then bore for the screws to hold ledges to outside or last board. Fasten ledges here also and then turn over door and nail through from face into ledges. The position of the latter can be indicated by a couple of lines. Nails long enough to protrude and be clinched are necessary on light doors, and the ledges should rest on two pieces of waste board while they are being driven. When stouter ledges are used the nails can be long enough to go well into, but not through, them.

Having prepared a piece of board for the diagonal, lay it in the position it will occupy, resting on the ledges at top and bottom, and mark the angle it makes with the ledges. Next cut the brace to shape, so that a portion is left at each end on the outer side and the remainder is cut back to the line of the ledge. In our diagram the

piece of wood to be cut away is shown by broken lines. The angle of the cut will depend on the amount of slope given to the brace, and this, of course, is regulated by the width and height of the door. A bevel square should be used to transfer and mark the angles, or a rule can be utilized by bending the joint to the proper angle and holding it firmly when pencilling the lines on brace or ledge. Lay the brace on ledges in correct position and mark from it the notches in the latter. Keep well within the lines when cutting the notches, so that a tight fit is secured when brace is pressed into place.



LEDGED AND BRACED DOOR FOR COAL BUNKER

The boards, where the brace crosses them, are nailed to it from the front. If the top and bottom have not yet been squared off and sawn to proper length, this can now be done and another coat of paint applied. The door should be an easy fit in its frame, for it will be exposed to weather and be likely to stick if insufficient clearance is not allowed. When hinges have been screwed on, raise the door to its proper position by two slips between it and the sill (or the floor, as the case may be) and screw hinges to door-frame. Galvanized iron screws should be employed for all outdoor work of this description. It is usually possible to get them with this finish if ordered in gross lots of a size, and the extra cost for galvanizing is only very small.

A larger door could be made up in the same way, except that three ledges and two braces would be provided. Inch floor board, tongued and grooved, would be a suitable material for the covering and three strap

hinges would be advisable, one over each ledge. In good-class work the upper edges of ledges and brace are bevelled so as to prevent water lodging on them.

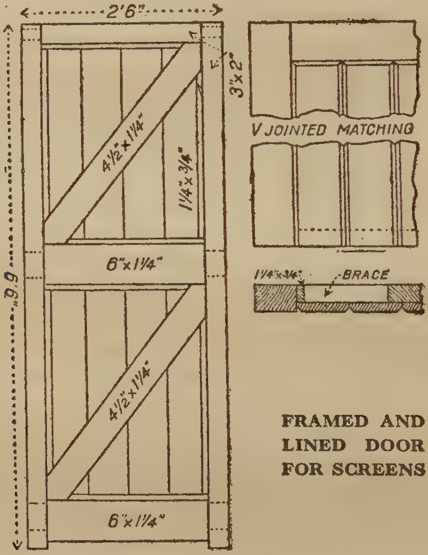
Framed and Match-lined Door.—When a door with a better finish is required for an outdoor location—in a screen at the side of a house, for instance—a framed and lined one can be made up in the manner now to be described. The stiles and top rail are of 3-in. by 2-in. deal; the middle rail and lower rail stand-in to the thickness of the matching, which lies over them and is flush with the top and sides of the framing. Thus with a ¾-in. lining the middle and bottom rail would be only 1¼ in. thick. A fillet of 1¼-in. by ¾-in. deal is screwed to top and sides all round to support the matching at the edges. Between top and middle rail and middle and lower rail are diagonal braces, and these also are 1¼ in. thick. The match-lining is of the V-jointed pattern, and narrow boards look well in such a job. At the top and sides a bevel is worked to match the joints. The boards overhang the lower rail about an inch.

The diagram shows a door 6 ft. 6 in. high by 2 ft. 6 in. wide. The rails are through-tenoned and wedged to stiles. The middle and lower rails are flush with the back of door, and stand-in from the face; the braces also are of similar stuff and come out flush with stiles at back. Prepared, i.e. planed, timber should be ordered and good sound stuff selected. The 1¼-in. by ¾-in. fillet that is screwed to top rail and stiles all round must be bored and countersunk for the screws, after fitting and trying in place. See that the holes are large enough to take the shank of screw without any danger of splitting. The braces are to be a tight fit, but not so large as to need forcing. All such parts should be painted after fitting and before fixing, since the inner sides will be inaccessible later.

The boards for the face should be cut off in one length and joints tried together.

It may be a little difficult to procure matched boards of the dimensions needed, so that all may be of the same width across the panel. Matchings are supplied in a limited range of sizes and thicknesses, and unless our door is of a width to accommodate one of these we must joint and bead the boards ourselves or get this done at a sawmill; it is generally possible to get boards machined

with a V-joint and a groove on both edges and to joint them with a slip or feather. The boards are to be bevelled off at top edge to show a V-groove, and so carry the line round the head of door. The little extra trouble entailed in these details is well repaid by the superior appearance of a well-made door finished on these lines. Three coats of lead paint are to be applied, working the



FRAMED AND LINED DOOR FOR SCREENS

brush well into the joints of the matching. Hang the door to frame with three butt hinges and grease the screws before driving.

It may be that a door of the type just described is desired with an open top panel in which trellis is to be fixed. Very little alteration is needed to the design. The matching comes up to the lower edge of locking rail, which in such a case may be located a little higher —3 ft. 6 in. from bottom of door. The trellis rests against a rebate formed by a fillet of ¾-in. deal fixed inside opening, all round. The middle or locking rail is of the same

thickness as top rail and stiles, and only the bottom rail stands-in behind matching. With slight modification a glazed top panel can be arranged; though the method of construction is unconventional it will be easy of execution by the amateur.

Hanging a Door.—The hanging and adjustment of doors are simple operations, but unless they are done with the greatest accuracy a bad fit is almost inevitable; and a badly fitting door will reveal itself in draughts, rattling, and sticking and consequent warping of the door itself. It is important to bear in mind that very slight inaccuracy in the placing of a hinge, either where it is screwed to the stile of the door or to the edge of the door jamb, will be multiplied considerably as the opposite stile of the door is approached, since any part of the door in the direction of its width may be regarded as a lever.

All panelled doors are hung on hinges that are technically known as "butts," consisting of two rectangular plates of metal connected by loops and a pin. The correct position for butt hinges is between 5 in. and 6 in. from the top and 10 in. from the bottom of the door, the butts being sunk flush with the surface of the wood, with the knuckle protruding. These positions should be marked out on the door by holding the hinge in place and running a scriber or sharp pencil round its outline. The edge of the stile must not quite extend to the centre of the pin of the hinge, otherwise the stile of the door will not clear the moulding when it is opened wide. The same point must be borne in mind when marking out the position of the hinge on the door jamb, a slight clearance being provided between the edge of the jamb and the centre of the hinge pin.

The recesses for the flanges of the butts should now be cut out in the door stile with a tenon saw and chisel. Take care not to make these recesses too deep, or there will be a danger of the door binding against the moulding when it is opened, thus entailing a severe strain on the screws. On the other hand, if the flanges are not recessed deep enough, the door will not fit closely in its frame, and a gap will be disclosed when it is opened. If by accident the recess is cut too deep, however, a little packing with strips of thin card or of brown paper will often adjust matters correctly. The butts should now be screwed

firmly to the door with countersunk iron screws, turned in dead true.

At this point the positions of the butts must be set out on the door jamb. Lift the door into place, pressing it firmly against the stops of the door frame on all three sides. Now insert a couple of thin wedges under the door, so as to raise it sufficiently to clear the floor when it is opened. The successful hanging of the door depends very largely upon the care that is taken over this operation. A well-fitting door should show a uniform clearance at the sides and top that is about equal to the thickness of a new penny; the latter, indeed, forms a very convenient gauge for determining when the door is correctly wedged up.

Now open out the hinges and mark round them accurately on the door jamb with the scriber. Also mark out the thickness of the knuckle, or cylindrical centre part, of the hinge on the edge of the jamb. Remove the door and cut the recesses with a chisel. The surface of these recesses will not be parallel with the surface of the door jamb, but must slope a little in the direction of the door, for one side of the flange is to be let in as far as its own thickness, while the other side is to be recessed deeper, so as to accommodate the knuckle of the hinge as well. Before removing the door, the centre of one screw-hole in each butt should be carefully marked, and a guide hole should be bored for the screw *before* the recesses are cut.

Now hang the door temporarily with one screw in each hinge, and gently open and close it to see whether it works properly in every respect. It should hang quite clear of the floor, and its edges should not foul the inside of the door frame when it is being opened or closed; neither should the stile of the door on the hinge side bind against the moulding when the door is bent back at more than a right-angle. When the door has been perfectly adjusted holes can be bored with a gimlet for the remaining screws, and the latter can be driven home.

Rising Butts.—When a door refuses to clear the floor covering, such as a thick carpet, it can be made to do so by fitting "rising butts" in place of the ordinary hinges. In the frame the knuckle of the hinge is cut in the form of a spiral, and one half of the hinge is free to rise around

a fixed pin as the hinge is opened, thus raising the door ½ in. or so to clear the carpet.

A "Sticking" Door.—If a door will not close or open properly, it is more than likely that there is something the matter with the hinges, and every effort must be made to readjust them properly before resorting to the drastic remedy of planing or rubbing down any part of the door itself. It often happens that a door which has been in perfect order for years will begin to stick and bind against the frame or the lintel. The cause of the trouble is very probably that the screws securing the hinges—especially the upper hinge—have worked loose in their holes, and all that is necessary is to tighten them up. Sometimes it will be found that, owing to the constant friction set up by the loose screws, the holes have become enlarged, so that merely turning the screws with a screwdriver will not be sufficient to tighten them. In this case either thicker screws should be fitted or the holes may be plugged tightly with wood and fresh holes bored. In a very bad case it may be necessary to shift the hinges a little higher or lower, so as to get a grip for the screws in new wood.

When the closing edge of a door sticks against the frame the handyman may be tempted to plane down the front edge of the door; but a little reflection will show that the lock would have to be set farther back in the door by an amount that is equivalent to the thickness of wood removed with the plane. Obviously this would entail filling up the keyhole and cutting a new one farther back in the door—altogether a considerable amount of labour. The correct remedy is to remove the door from its hinges and cut the recesses of the latter a little deeper into the wood; in extreme cases it may be necessary to plane the *back* edge of the door, in addition to recessing the hinges deeper.

If the lower edge of a door binds against the lintel on the side farthest away from the hinges, try recessing the upper hinge deeper into the jamb. If the trouble lies on the side near the hinges, deepen the lower hinge. In any case, whenever a door begins to stick it should be attended to immediately, for if the trouble is allowed to continue there is a likelihood of the door becoming badly warped, to say nothing of the strain upon the door

frame and the hinges. Meanwhile, the pressure exerted to open or close the door should as far as possible be exerted immediately over the place where it sticks, in order to minimize the risk of warping.

Taking Down a Door.—When a door has to be removed, it is often very difficult to loosen the screws by which the hinges are attached. If the amateur has a brace fitted with a screwdriver bit, he may find the extra-powerful leverage exerted by this tool all that is necessary in starting a stubborn screw, but the following method will also be found useful. First scrape the slot in the head of the screw free from old accumulations of paint and varnish. Then insert the blade of a large screwdriver in the slot and give the other end a few blows with a mallet. The screw should then be found to move quite freely. Before replacing the screws, dip them in vaseline, which will render them quite easy of withdrawal on subsequent occasions.

When re-hanging a door, wedge it up from below, as already described, to the exact height at which it is to hang. Drive a screw through each hinge alternately, beginning with the upper one. When a door has to be removed, unscrew the hinges from the jamb, and not from the door itself.

Preventing Draughts.—There are few things more annoying than a door which admits draughts when it is closed. There are several ways of overcoming the defect. If appearance is not of primary importance a strip of stout felt may be nailed to the surface of the door all round the top and side edges; it should be fixed with small tacks, or preferably, japanned brads, spaced about 1 in. apart. It must be observed, however, that in many cases this device does not prevent the draught entering, but serves merely to deflect it to one side. The job can be done more effectively, therefore, by tacking tubular rubber draught-proofing along the edge of the door. When the door is closed, the rubber tube is tightly pinched against the face of the jamb, forming an air-tight seal; this rubber slip can be painted to match the surrounding woodwork.

Draught can be prevented from entering under the bottom of a door by fitting a wooden roller covered with baize, which is supported at either end by a metal

bracket provided with an upright slot. The roller is free to rise in the slots, and thus can surmount carpets and rugs, while at the same time maintaining a close contact with the floor. A neater device is the flat type of draught-excluder fitted with a narrow strip of rubber. When the door is opened, simple mechanism raises the whole device clear of the floor. In fitting these appliances the instructions of the makers should be followed; no particular points of difficulty will be found to present themselves.

It sometimes happens, when a room has a surround of polished wood or linoleum with a thick rug in the middle of the floor, that an exceptionally wide gap is left between the bottom of the door and the floor, merely in order that the door may clear the edge of the rug when it is opened. The draught that is bound to enter such a wide gap is regarded by the owner as a necessary evil, and probably an attempt is made to get rid of it by fitting felt or a draught-excluder. The proper course would, however, have been to fit a pair of rising butts, which we have already described, in place of the ordinary hinges; and a case like this can be remedied by lowering the door, so as to reduce the gap to normal, fitting rising butts to raise the door above the carpet, and compensating for the increased gap at the top of the door by fitting a thicker stop, or else neatly nailing a thin slip of wood to the top of the door to increase its height.

Draughts can often be traced to a badly fitting door-stop. Sometimes—especially in the case of a street door that is exposed to the weather—the stop warps and springs away from the jamb or lintel, leaving a wide gap. When this occurs, the stop should be removed, and all dirt, dust, cobwebs, etc. cleaned away, before the stop is re-nailed (or preferably screwed) into place. Care should be taken in replacing a door-stop to see that its edge forms one line with those of the other stops; otherwise the door will either refuse to shut properly, or else rattle persistently.

Locks.—Fitting a rim lock to a new door is a simple matter. Lay the lock against the middle rail of the door in the position which it is to occupy, and draw a line on the edge of the door all round the flange at the bolt end of the lock. With a chisel cut out a recess where

marked, just deep enough to allow the flange to be sunk flush with the edge of the door. Now mark with a scriber the positions of the holes for the screws that are to hold the lock in place, and also the holes for the keyhole and spindle; this marking must be done with the greatest accuracy. Remove the lock, bore the screw holes with a gimlet, and the hole for the spindle with a brace and bit, being careful to keep the bit absolutely at a right-angle in all directions with the surface of the door.

A simple method of keeping the bit horizontal is to slip a small curtain ring over it loosely, when any deviation from the horizontal will be betrayed by the ring sliding in one direction or the other. To keep the bit true from right to left, hold a try square against it. When the point of the bit appears on the other side of the door, withdraw the tool and complete the hole from the other side, so as to prevent splintering of the wood. Now bore a hole at the exact top and bottom of the place marked for the keyhole and cut out the intervening wood with a keyhole saw.

The lock should be screwed on with round-headed screws, although countersunk screws must be used for the flange. Fix on the handles, and also the rose and keyhole escutcheon (the last two on the other side of the door). Finally screw the box staple to the jamb of the door, seeing that there is a space left above the bolt and below the catch, and also allowing a little lateral play.

DOVETAILS.—Dovetails are among the commonest and most important glued joints in woodwork. They are employed for joining two pieces of wood at right-angles, especially when the joint has to withstand a forward pull on one of the members, an excellent instance being the attachment of the front of a drawer to the sides. There are several varieties of dovetail joint in common use, and the simplest and most generally useful of these will be described later on; however, the construction of only one of these joints will be described in detail—that of the common or box-dovetail—since it sums up the general principles upon which all dovetail joints are made. The amateur is not recommended to attempt the more complicated forms, which call for a

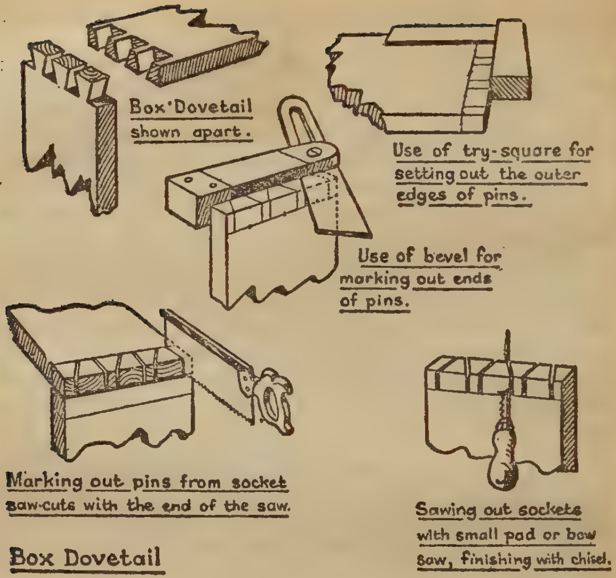
great deal of skill and experience if they are to be properly constructed.

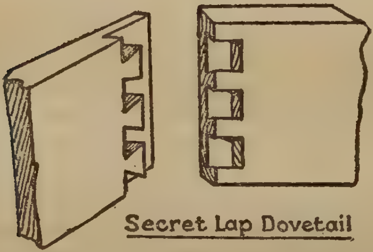
Each single dovetail in a joint consists of two parts: the socket, which is cut so that its two free sides converge slightly towards one another; and the pin, which is of the same shape and size as the inside of the socket and therefore fits into it closely. Unless the parts are cut with the greatest accuracy, this close fit will not be obtained, and the dovetail will be practically useless. Therefore, all marking should be done with a marking gauge and a sharp scriber. Saw kerfs should be made inside the waste wood, though close to the marked line, and paring should be accurately done with a sharp chisel. The work must be firmly held in the bench-screw while the dovetails are being cut.

It is important first to true up the end of each piece of wood that is to form the joint, planing it perfectly square with the face and edge of the wood. The pins of the dovetail are to be made first, and they must be made in the piece of wood whose length lies in the direction across that in which the pull will operate when the joint is in use. For instance, in the case of a drawer, the pins would be formed in the ends of the front, while the dovetails would be in the sides of the drawer. If this arrangement were reversed, the pull upon the front of the drawer in opening it would very likely cause the joint to come apart.

At each end of the board in which the pins are to be cut, and on both sides of it, gauge lines from the edge to represent the thickness of the piece of wood that is to contain the sockets. Having decided upon the number and proportions of the pins—which, of course, will depend upon the nature of the material and the purpose for which the article is intended, and can only be correctly judged after some experience—set out a half-pin at each extremity, and then divide up the space between them into the requisite number of pins, setting out the narrow parts of the latter along the shoulder line with a pair of dividers. Parallel lines are then marked from the bases of the pins on the shoulder line to the edge of the wood.

The work is to be clamped in the bench vice with the end uppermost, and the splayed ends of the pins marked out with the bevel across the end of the wood. The angle of inclination given to the pins must not be too





DETAILS OF VARIOUS DOVETAILS

great—say between 10° and 20° with the face of the wood—otherwise there will be a risk of weakening the sockets when any strain is exerted on the joint. Finally, mark out the inside, or broader side, of the pins on the other face of the wood by means of parallel lines joining the shoulder line with the ends of the sloping lines that

have just been marked. These parallel lines, as well as those already marked on the other face of the wood, are set out with a small try-square, and they must be very accurate.

Now saw down the pins from the end of the wood with a tenon saw or, better still, a dovetail saw, as far as the shoulder lines on each side. Cut out the waste with a chisel, working from both sides of the wood and taking care that the edges of the pins are quite straight and clean and that the parts on the shoulder line are perpendicular with the face of the wood.

The sockets must now be set out on the sides of the box, using the pins made on the front as a guide. First mark a shoulder line on each face of the board, setting it as far distant from the edge as the thickness of the piece on which the pins have been formed. Then place the two pieces at right-angles to one another with the wide face —or inside—of the pins against the shoulder line, and draw a sharp awl or scriber round them closely, so that their outline is transferred to the inner face of the piece that is to contain the sockets. Square lines across the end grain of the wood from the outer extremities of the lines just made, and then mark out the lines for the sockets on the reverse side of the wood, using the bevel, which should be adjusted by the lines which have just been made on the other side. Finally, cut out the socket with saw and chisel, in the same manner as that employed for cutting out the pins. The half-socket at each end must be sawn off at the shoulder line. A lot of work can be saved by boring out the bulk with the brace and bit and then removing the remaining waste wood with the chisel.

The accuracy of a dovetail joint should never be tested by knocking the pieces together experimentally before they are finally glued and assembled—as can be done with most other joints—for this is almost bound to damage the corners of the dovetails, entailing a loose fit. To assist in fitting the parts together, however, the inner arrises of the sockets may be lightly bevelled off with the chisel. Then give the joint a liberal coat of hot glue and knock it together gently with a mallet, holding a piece of waste wood between the tool and the joint, in order to prevent the work from being bruised.

Lap Dovetail.—This joint is a somewhat more complicated form than is generally used for attaching the fronts of drawers to the sides, its advantage being that the joint is not visible from the front, since the pins do not extend right through the thickness of the wood.

Set the marking gauge to the thickness of the sides of the drawer, which will be thinner than the front, and mark a shoulder line, as has already been described for setting out a box-dovetail. Then set the gauge to the distance by which the side laps on to the end of the front piece and mark a line round the edges of the latter, using the gauge on the inner face of the wood. Set out the pins as has already been described, taking care, however, that it is their *wider* faces that are marked on the shoulder line. A half pin should be left at each end of the wood, and the waste wood lying between the pins can be marked with a pencil so as to avoid confusion. Set out the angles of the pins on the end grain as far as the gauge line, and after cramping the wood end upwards in the vice, make saw kerfs down the sides of the pins, holding the saw on the slant. The waste can then be chopped and pared out with a narrow chisel.

Now gauge a shoulder line on the pieces forming the sides of the drawer, setting it as far from the end of the wood as the *depth of the pins*, and not as far as the thickness of the wood forming the front piece. Then, setting the pins to this shoulder line, mark out the sockets, as already described, and cut them out with saw and chisel.

The Secret Dovetail is a similar joint to the last, except that the sockets are stopped—that is, covered on the outside by a lap or rebate—so that when the joint is assembled the ends of the pins butt against this lap and are concealed by it.

The pins are set out as for the ordinary lap dovetail already described, and it is only the sockets which need further description. They go only partly through the thickness of the wood, so as to leave a lap of the required thickness; and, moreover, the ends of the sockets are set in from the end of the wood, so as to leave a plain rebate, which will be as deep as the thickness of the corresponding stopped part in the piece containing the pins.

According to the requirements of the work in hand, the relative positions of the pins and sockets can be reversed—that is, the sockets can be formed in the square-ended piece of wood, while the pins are cut in the piece containing the lap or rebate.

DOWELS AND DOWELLING.—Cylindrical pins called dowels are often used in woodworking to reinforce a glued joint, having the advantage of being invisible when they are in place. They should be made of hard, close-grained wood, such as beech or oak, perfectly free from knots and with the grain running lengthwise. It is important that they should be of the same diameter throughout their length, with absolutely parallel sides; otherwise they will make a bad fit and so defeat the purpose for which they are intended.

Dowels may be bought ready made in lengths of 3 ft. or so, known as dowel sticks, or they may be made in the workshop as occasion demands. They can easily be turned in a lathe, using a broad chisel for the purpose. A much better plan, however, is to make them with the aid of a dowel-plate, since they can then be formed to a precise gauge without the slightest deviation in diameter; and when the holes which are to receive the dowels are drilled with a twist or dowel bit of the same diameter, a perfect fit is assured. If dowels are too thick they may split the wood in which they are inserted; if too thin, the joint will be weak and inaccurate. A dowel-plate is a thick, rectangular piece of steel which can be screwed to the bench, and is pierced with round holes of different gauges. To make a dowel, select a piece of suitable wood, split it to the approximate size of the pin required and slightly taper it at one end. This rod of wood is then driven smartly through the hole of the required gauge, and comes out perfectly rounded at the other side, requiring only to be cut to length with a tenon saw.

When this has been done, trim off the sharp edges slightly with a chisel, so that the pins can be inserted more easily; if a quantity have to be trimmed, the operation may be done with a dowel shaver bit, which fits into the brace and acts very much after the fashion of a revolving pencil sharpener. On no account, however, should a dowel be pointed or whittled away at the ends, for this will lessen its holding surface and so weaken the

joint. To allow the air and surplus glue to escape when the pin is being driven home, a narrow cut should be made lengthwise in the dowel by means of a tenon saw or a fine parting tool. The latter is a V-shaped gouge-like chisel.

To ensure a successful joint, the thickness of the wood that is being dowelled should be at least three times the diameter of the pin selected; and it must be remembered that a dowel driven into end grain, especially of soft wood, does not give so strong a hold as it would if it crossed the grain. Sometimes dowels are inserted obliquely to the surface of the wood, a practice that is considered to yield a stronger joint. Dowels inserted in groups of two or more must be absolutely parallel to one another.

The holes to receive dowels must have their centres marked with the greatest exactness, for the slightest failure to register truly one with another will spoil the joint. A method of marking them out is as follows. The two halves of the joint should be laid accurately together and pencil lines drawn across the join at the intervals where it is desired to insert dowels. The boards should then be separated and lines should be drawn across their edges with a try-square at these points. A marking gauge must then be set to half the thickness of the wood and lines scribed at right-angles through the other lines which have just been made. The intersecting points of these lines will indicate the centres of the dowel holes.

When this method of marking is impracticable, as often in repairing furniture, another may be resorted to. When one centre has been determined upon and marked, the other should be obtained in the following manner: Place upon the first point a small piece of graphite or black-lead—a tiny fragment of pencil lead is often used—making a slight depression, if necessary, to keep it in place. If the work has a dark surface, such as a piece of polished mahogany, a minute spot of white paint should be used instead. Now bring the two portions of the work accurately together, exerting a slight pressure, and on separating them again the centre of the second hole to be drilled will be found clearly marked.

If a number of rails or stiles all uniform in size have to be dowelled into position, a great deal of time and labour can be saved by marking points for the holes by means of

a thin metal template, formed from a piece of sheet tin, brass or zinc. One edge should be turned over at right-angles for a fraction of an inch. The template is applied to all master rails, after this has been gauged, and pierced with very small holes at the points where the dowels are to go. It is then transferred to the other rails in succession and the points pricked through.

For the dowels to fit properly without being strained into place, each hole must be a perfect continuation of the other, in exactly the same plane; hence the angle of the bit must be carefully watched during boring, and, if necessary, corrected. It is desirable that the depth of both holes be the same, and this can be attained by means of a depth gauge fitted to the shank of the bit.

When the hole has been bored, it may be very slightly countersunk, as a precaution against glue or any other obstruction forming in the angle of the dowel and preventing the close union of the joint.

When the pin has been made of a size to fit closely in the hole, but without any forcing, the inside of the latter should be covered with hot glue by means of a small clean brush, and the pin tapped home. The surplus glue that is forced out should be wiped away, and the projecting part of the dowel should be cut to a sufficient length to fill the other hole accurately—if this has not already been done—and have its edge trimmed. Both the projecting dowels and the edges of the wood to be joined should then be well glued, pressed together and cramped. It is a good plan to warm the edges thoroughly before gluing the joint, in very cold weather.

It is essential that the edges of the two pieces of wood to be butt-jointed in this way should make a perfect fit with one another, otherwise a disproportionate strain will be thrown upon the dowels, which will probably yield in time. Hence the joint must be shot truly with a jack-plane and the edges tested with the square.

When a number of pieces of wood, such as narrow stiles and rails, have to be butt-jointed at the end, they can be laid together in a mitre-box that has been made specially for the purpose out of any odd wood and which can afterwards be discarded. The rails are wedged into the box, a square is laid across the top, forming a perfect

right-angle with the sides, and a cut is made close against it with a tenon saw or deep back saw. The saw should then be taken right through the material in the box, while the greatest care is exercised to see that it is perfectly upright. In this way, several joints can be made in one operation.

Dowels will often be observed in a loose joint, such as the sliding leaf of a dining-table or the removable front of a piano, etc., the pin being glued half-way into one portion of the joint and projecting into a hole in the other portion when the latter is in position. In such jobs, care should be taken over the sighting of the holes before they are bored. In order to provide a sort of guide for the entering peg, the open hole may be very slightly countersunk or reamed out at the edge.

Old, broken dowels can be removed from furniture, etc., by drilling them out with a centre-bit or auger-bit of appropriate size, being careful to remove every particle of old wood and glue. New pins should then be made and inserted as has been described.

DRAINING BOARD.—The draining board to a scullery sink is often a very poor affair, too narrow or not long enough. A new one, lined with zinc, is fairly easy to construct and costs little. This fitment rests upon the sink at one end and upon a batten fixed to the wall, or upon a bracket, at the other. It must be given a slope towards the sink and an inward "cant" also, in order that drippings from crockery are led towards the sink. The usual fitment is made of stout stuff grooved or channelled on top, the two or three boards that make up the width being ploughed along the meeting edges and connected by a loose tongue or "feather."

We can use good sound inch floorboard for the bottom of the draining board, the "T. and G." variety being employed. The width of board selected must be that most adaptable to the dimensions of the fitment. Try the boards together, after they have been cross-cut to the proper length. Take off the grooved portion from one outside board and the tongue from the other. Two battens of $\frac{7}{8}$-in. by 4-in. deal or hardwood are screwed on beneath to hold the boards together. In this part of the work a pair of wooden cramps would be handy, or else a sash cramp. Lay the boards in the cramps, squeeze

up so that the joints meet, and screw on the battens. Brass screws should be used to obviate rusting.

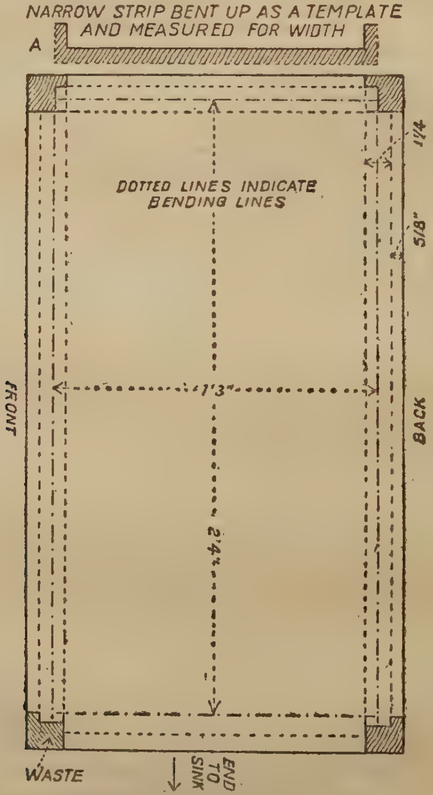
On top of the board, at far end, back and front, we shall fix a ledge of 1¼-in. by ⅝-in. deal on edge. The end abutting on the sink is left open. Long brass screws are driven into the ledge from beneath in holes bored clean through bottom and entering the under side of ledge. Use two sizes of bit, one for the clearing hole and a smaller one to continue the bore into ledge. At the corners the 1¼-in. by ⅝-in. stuff is mitred. When this part of the work is completed the draining board can be cleaned up. See that the raised ledge is free from any splinters or projections.

Zinc Lining.—Measure accurately the width inside the ledges and the length from inside of back ledge to open end of fitment; add to this, in the case of the width, twice the height of the ledge (1¼ in.) and twice its thickness (⅝ in.). This gives the nominal width of the sheet of zinc to be procured. The length inside plus the height (1¼ in.) and thickness (⅝ in.) of the ledge, and plus 2 in. for turn at the open end gives us the length of the sheet. We recommend the worker to make a full-size drawing on a sheet of brown paper of the lining as it would appear laid out flat. On this he can mark the cutting lines and the bending lines. We give a sketch of the zinc sheet for a draining board 2 ft. 4 in. long by 1 ft. 3 in. wide. This will be a guide in preparing one similar to the size desired. It must be remembered that in practice each bend will "take up" some of the material, and in consequence the sheet must be longer and wider to allow for this.

The amount of allowance will depend upon the sharpness and accuracy of the bends; the worker should first try a narrow strip of the metal (say 2 in. wide) across the board, bending it to an angle for the side of ledge and the overlapping flange on top edge. In our diagram the template thus bent up to fit into board is shown at A, the draining board being indicated in cross section by dotted lines. Measure total width of template and cut the sheet to it. Next, carefully scribe and rule the cutting and bending lines on the zinc, cut away the waste at corners, make the slots for the overlap, and bend up to shape. In the article MAKING A BRAZING PAN, page 326,

are useful hints on forming a tray in sheet metal. This can be referred to for further information.

When tray has been formed up, the overlaps at end remote from sink are to be closed to the corners, cleaned



ZINC SHEET FOR DRAINING BOARD

up with emery cloth and soldered to a water-tight joint. Zinc is best soldered with a flux of "unkilled" or "neat" spirits of salt, and care must be taken not to melt the material. Though many amateurs are chary of attempt-

ing such a job, it is not difficult if tackled in a careful manner. Do not try to use an insufficiently heated copper bit; a really hot soldering iron is less likely to burn the metal, for the solder runs more readily and the bit is in contact with the zinc for a shorter period in consequence. After soldering, try tray in its location; the flanges that lie over edge of $1\frac{1}{4}$-in. by $\frac{5}{8}$-in. ledge are now to be bent into place. Beneath each corner, where there is a rectangular gap in the flange, a shaped piece of zinc must be placed. It can either be soldered beneath flange or merely laid in position and tacked down with the flange.

The zinc projecting at the open end is bent down and under to cover edge of board; a short turn at each side has been left to be bent back against vertical edge of $1\frac{1}{4}$-in. by $\frac{5}{8}$-in. ledge. After making sure that the tray fits everywhere, trim off edges flush with snips, and tack down flanges with copper tacks. No tacks should be needed in bottom of tray, but if any are used a little solder should be run round each head afterwards to prevent water leaking through. Though the description may seem somewhat complicated, the execution of this job is not formidable, and a draining board so made will be a durable and satisfactory fitment far superior to the ordinary wooden one. The methods suggested are, in our judgment, the best for the amateur to use, bearing in mind his few tools and lack of skill and practice.

DRAWER.—An ordinary drawer is a very simple and easily constructed article yet, unless it is made with care, it is liable to prove an endless source of annoyance owing to jamming and sticking against the runners upon which it is meant to slide. Practically all drawers are put together upon the same principle, and so we shall choose one of the commonest kinds for our example—that of a dressing-table or chest of drawers—leaving the reader free to adapt the method of its construction to suit any particular job which he may have in hand.

The front of a drawer is generally made of thicker stuff than the rest of it, since it has to present a solid and well-finished appearance. It should be sawn from a piece of strong, straight-grained stuff about $\frac{7}{8}$ in. thick and thoroughly well seasoned—which latter requirement extends to the whole of the timber from which the drawer

is constructed. Setting aside inaccurate joints and other forms of bad workmanship, perhaps the chief reason why drawers stick in opening and closing is that the wood has become warped owing to not having been properly seasoned in the first place.

The face side and top edge of the drawer front are usually the only parts of the article that are finished—either by being painted, polished, or veneered; in all the other parts the wood is left in its natural state.

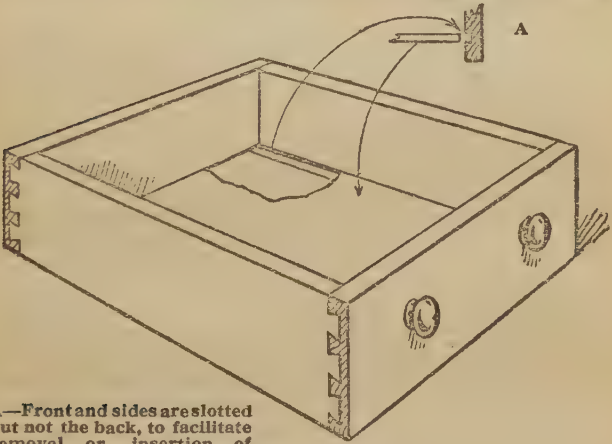
The sides of the drawer may be from $\frac{3}{8}$ in. to $\frac{1}{2}$ in. in thickness. About $\frac{1}{2}$ in. from the lower inside edge of each of them a groove is ploughed to take the bottom of the drawer, which is afterwards slid in from the back. The front is also grooved, and the sides are then fastened to it by means of a lap dovetail joint, which cannot be seen on the front of the drawer. The pins of the dovetail are cut in the front and the sockets in the sides, and the joints should be planed off quite smooth after gluing up.

The back is fixed to the sides, in the best class of work, by means of an ordinary box dovetail joint; although a strong and effective substitute for dovetailing is furnished by housing the back into grooves cut in the sides, the latter being left to project backwards for about $\frac{1}{2}$ in.; the housed joint should be glued and fastened with thin nails punched below the surface. It is a common practice to leave the back of a drawer about $\frac{3}{8}$ in. lower than the two sides, and it must be noted that in any case it extends only as far downwards as the bottom of the drawer, so that the bottom may be slid into place beneath it without any obstruction.

The bottom is usually made of much thinner wood than the rest of the drawer. Three-ply wood serves the purpose very well. The bottom must not fit too tightly when slid into the grooves or it may be split as a result of variations in temperature. It should be glued into the front groove, or fastened with thin nails from the bottom of the groove. The rear part of it is fastened to the back of the drawer in the following fashion: In the bottom of the drawer two slots are made, about $\frac{1}{2}$ in. long and pointing from the back to the front. The centre of each slot should come just in the middle of the thickness of the back of the drawer. Screws are then inserted through the slots and into the bottom edge

of the back, and screwed up fairly tightly, but not so far that their heads crush the wood. By this means the bottom is free to move in either direction in the grooved sides, and all fear of splitting and warping is avoided. The drawer-bottom must not be fastened in the side grooves, however, in any way whatever, or the precaution will be rendered useless.

If the amateur does not desire to go to the trouble of ploughing a groove in the sides of the drawer to receive



A—Front and sides are slotted but not the back, to facilitate removal or insertion of drawer-bottom if necessary

DRESSING-TABLE DRAWER

the bottom board, they can be left plain and a narrow fillet of wood can be nailed to them upon which the bottom board can rest. The bottom of the drawer-front may be rebated and likewise furnished with a wooden fillet, but it should be understood that this is not such a strong method of construction as the one involving a ploughed groove.

In the article on KITCHEN TABLE the reader will find an illustration of a simple drawer of which the bottom is fastened to the sides by means of a V-shaped slot, which takes the place of a ploughed groove. In this case, the drawer bottom must be chamfered off to a V-shape round

the edges, so as to fit into this groove. It will be observed that the front and back of this drawer are rebated to receive the sides. This offers a very simple method of construction which is particularly convenient for the novice, but it is one that can only be employed for rough work. Moreover, apart from its superior appearance, the lap dovetail possesses a great advantage over other end joints in the resistance which it offers to pulling strains, which, of course, are exerted every time the drawer is opened.

For opening and closing the drawer, drop handles or some form of knob must be fitted. They are inserted through a hole bored in the drawer-front, and screwed up from behind. The majority of drawers are also fitted with a lock, placed in the centre of the top front edge. A recess must be chiselled out to receive the lock, the brass plate of which is let in flush with the surface of the inside of the drawer-front. The bolt hole in the rail above the drawer must be cut very accurately. Its position can be marked as follows: Smear the top of the bolt with paint or lampblack and, with the drawer in the closed position, turn the key so that the bolt strikes against the wood of the rail and leaves a clear impression. Then remove the drawer and cut out the bolt hole with a drawer lock chisel. The keyhole can be finished off with a small brass flush escutcheon, which is tapped into the hole and lies flush with the surface.

Two small flat blocks, cut from ½-in. stuff, are fastened to the front bearer over which the drawer passes, to act as stops in order to prevent the drawer from going in too far. They should be glued a little in advance of their correct position and, on the drawer being gently inserted, they will be pushed back to their proper place. They should afterwards be secured with a couple of thin brads.

FENCES FOR THE GARDEN.—To the owner-occupier or tenant of a house his fences are sometimes a problem. The erections of the builder are often of the flimsiest nature—anything that will pass muster for a fence is put up to sell the house, and it is a fact that this part of the property is little regarded by many who purchase a house, perhaps because there are so many other details that clamour for attention. Privacy of a limited degree is attained by the provision of a close-

boarded fence for the first twenty feet or less of the boundary that divides neighbouring gardens, but for the rest this consists almost always of wire-link fencing of some sort or other, fixed to angle iron standards. Most house-owners wish to substitute something of a more substantial nature as soon as this is practicable.

Cleft chestnut fencing is cheap and durable when a more or less temporary erection is desired. It is sold in rolls of specified length, and supplied with the necessary posts. The latter are inserted in holes first made with a beetle or mallet and "jumper," or are driven in directly by blows of the beetle. Some difficulty is generally experienced in straining the fence preparatory to stapling it to the posts. The best way to deal with this is to use a pulley tackle, of which one block is fixed to a stout temporary post driven in at an angle some feet beyond the post that is to take the end of the fencing to be brought forward. The other pulley-block is attached to the fence; a helper first takes up the slack and then exerts a sufficient pull on the fence to strain it, while his mate fixes it to posts here and there. It is almost hopeless to try and pull the fence taut without some such straining device.

Close-Boarded Fence (*See* Fig. 1).—When putting up a fence that acts as a boundary between his own and other people's land the worker must avoid trespass or any deviation from the proper line. Usually permission is readily granted to go upon adjoining property for such a purpose. The line of an existing fence can be followed, and it must be borne in mind that the face of the new erection must come in the same line as that of the old; posts must be within the boundary on the fixer's side, and the fence must not overhang the line.

Fencing posts ready mortised to take the arris rails, and the rails themselves, can be bought at a timber yard; the better posts are left with the natural unsawn butts to give greater strength. Gravel board and cleft shingles or deal feather-edged boarding is used for the covering of the fence. The gravel board runs from post to post at the foot of the fence; its purpose is to make a neat finish at the ground line and to keep out loose earth or the gravel of a path. It is used, for example, in a fence that divides a garden from a public path or road,

but should be employed in any worth-while fencing job that the home worker undertakes. Not the least of its recommendations is the fact that it prevents dogs from burrowing under and intruding.

Lay the posts at the proper positions and dig holes for them. A line strung between two pegs driven into the ground will give the centre of the excavation. If a post has to be fixed against a brick wall or the side of the house at one end, it should be braced with a diagonal strut which rests at its lower end, in the ground, against

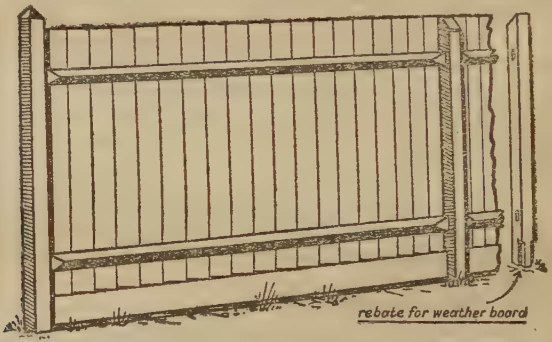


Fig. 1—INSIDE DETAILS OF CLOSE-BOARDED FENCE

a piece of 2-in. stuff laid at right-angles to it. The strut at its upper end is cut off at an angle and butts against the post. The end of the arris rail (which is triangular in section) is made oval and tapered so as to go into the mortise in post. When the end post has been erected the rails are knocked in, and the other ends inserted *also* into the next post as it stands loose in its hole. Earth is filled in to hold the second post steady and it is lined up with the first one; a plumb-rule or plumb-line is used to test the post for uprightness in two directions. When this is made correct the rest of the earth is filled in and rammed hard. The ends of the arris rails are secured in the mortises by stout pins driven through.

One bay of the fence having been erected in the manner described, the next is proceeded with. If the posts are set truly upright and at the proper height, the

arris rails will be square with them and truly horizontal. The flat face of the rail comes towards the outside or face of the fence and the oak pales or the feather-edged boards are nailed to this. In the case of oak pales it is essential, and in that of deal boards it is desirable, that galvanized nails be used. The gravel board is shaped at its ends into a sort of dovetail and let into the posts flush with the face of the work. The pales must be squared off at the lower edge before nailing to rails, and be levelled by the use of a line stretched between posts at the proper height. The upper ends can be sawn off square and level after nailing.

If a gateway is to be provided for, arrange it at the end of a complete bay of the fencing. The gate posts are to be concreted in and bonded during this process by nailing diagonally across them a couple of stout boards as braces. Stouter posts will probably be needed here. In a tallish fence a hoop made of stout wrought iron would be fixed near top of posts as a stay, being fastened by coach screws or by bolts long enough to go through posts.

A gate can be made up on a framework similar to that of the stout door described and illustrated in the article on DOORS. The stiles and rails of the framework would be mortised and tenoned together, and the pales or feather-edged boards nailed on outside to match the fence. A low gate could be arranged in a similar style on a lighter framework.

A simpler method of constructing a close-board fence can be used on lower structures. Mortised posts are set at longer intervals, and intermediate posts are sawn on the face so that the arris rail lies in a V-shaped recess flush with the surface of the post. The rails being longer than usual, are tenoned at the ends into the mortised posts, and are fixed to the intermediate posts by nailing. Rails should not terminate at the sawn posts.

Ornamental Fence or Screen.—A large garden often looks better when parted off by a low fence of simple design that will form a substantial support for roses or for climbing plants of other sorts. Since it is of an open nature, deriving its stability from a stout though by no means clumsy framing, it follows that it would be a waste of labour to build anything but the best type of

structure. Ready-made screen units and fencing panels are to be had in flimsy material at very low prices, but we advise the reader to have no truck with them; rather should he spend his money on timber and labour in building a fence for himself.

The fence illustrated in Fig. 2 can be 3 ft. 6 in. high from ground level and its posts go down 18 in. farther. It is made up of bays 6 ft. 3 in. long overall from one post to the next, including the width of the first post; 3-in. square deal is used for the posts, each of which could be surmounted by a square cap. The rails are of 3-in. by 2-in. stuff, tenoned into the uprights at 6 in. and 3 ft.

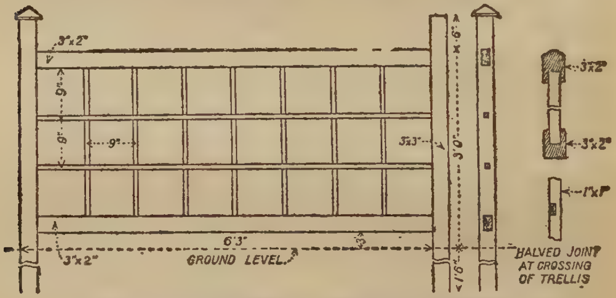


Fig. 2—ORNAMENTAL FENCE OR SCREEN

above the ground line, this measurement in each case referring to the top surface of the rails. The posts stand up a farther 6 in. and then there comes the cap, if one is used.

The trellis is cut from nominal inch square deal—actually it will be a little less in section, as prepared timber will be used. The verticals are to be let into the rails by mortises sunk to an inch deep. They can be spaced at 9-in. centres, eight to each bay. The three horizontals are mortised similarly into the posts at 9-in. centres. Where the verticals and horizontals intersect they are halved together and nailed. The amount of jointing may appear formidable, but if simple gauges are made for cutting the half-lap joints it will be merely a question of time and patience.

Centre-bit holes can be bored to lessen the labour of

mortising, but a depth gauge of some sort must be rigged up on the bit; and we advise that the improved type of centre-bit be purchased. Mark the centres with a pair of carpenter's dividers, and mark the width of the mortises accurately with a gauge.

Holes are to be dug in readiness for the posts, which are 6 ft. 3 in. apart. Set the first one and insert bottom rail; then put in the verticals and horizontals and ease on the top rail. The second post is now placed in its hole; this must be just the right depth to bring its mortises to the proper height, and the level of the lower rail can be indicated by a line stretched between two stakes. Insert the rails and the horizontals of the trellis into the second post, fill in a little earth to hold post steady, try the latter for plumb and test for squareness. Lay a spirit-level on rail and adjust post to bring the bubble central, and when all is correct fill in the hole and ram hard. All the joints of the rails with the posts are pinned to secure them; the trellis is fixed at the intersections with galvanized nails, and a heavy hammer should be held behind the crossing while the nail is driven in by blows of another hammer.

If it is decided to concrete the base of the posts it may be better first to assemble the whole fence, if not too long, so that it lies on the ground with the butts of posts in the correct position for placing into holes already dug. When ready, the fence is upraised with the help of an assistant and the posts allowed gently to drop into place. The posts are chocked temporarily or held by struts while the concrete is filled in to a depth of 8 or 9 in. and rammed home. The fence, when once levelled and its posts made upright, must not be touched until the concrete is set; the structure must also be made secure from disturbance by wind.

Every portion of the fence should be painted or treated with some preservative such as creosote, preferably after fitting and before fixing. A little lead paint should go on each joint before insertion if the fence is to be painted. The caps may merely be spiked on or they may be mortised to receive a tenon cut on the post. A flat square cap can be cut from inch board of a suitable width; it would be worth while, however, to use 1½ in. thick stuff and to plane off the top to a shallow pyramid in order

to throw off water. Then, too, the top rails might be weathered by planing off the arrises of the upper surface so that an inverted ʌ was formed. The top of lower rails could be sloped off slightly also from the trellis, adding finish to the job and lengthening the life of the structure.

An archway is easily contrived in such a fence, and in the article on ARCHES are to be found two alternative designs that, with little or no adaptation, would work well with any fence or screen of the kind. If a gate is wanted it should be made of a width to take, say, three or four meshes of trellis, so that these may be similarly spaced to those of the rest of the fence.

The uprights of the gate-frame should stand up above the rails about 3 in. and the tops be rounded off. Both uprights and rails would be of 3-in. by 2-in. timber mortised and tenoned together.

Repairing a Fence.—Close-boarded fences present a large surface to the wind, and in consequence are severely stressed by autumn and winter gales. Sometimes bays of the fence are blown clean over, or deflected so much that the arris rails are wrenched out of the mortises in the posts. The higher the fence, the greater is the leverage that the wind exerts upon it.

If posts have decayed at or near the ground level they are likely to snap. In any case a fence calls for immediate repair if the damage is not to go a great deal farther. We shall therefore consider the question from two points of view—first a temporary and rapid repair that will limit the damage; and, secondly, the making good of breakage and prevention of similar trouble in the future.

Temporary Repair.—When the fence runs alongside a garden border the best temporary measure is to drive in pointed stakes of 3-in. by 2-in. deal at a few feet from the line of the fence, opposite the posts that are to be strengthened. The stake should go down 1 ft. 6 in. to 2 ft. into the ground, driven by blows of a heavy wooden mallet. Let stake stand up about 1 ft. 6 in. above ground, its narrow edge facing the fence and in line with one side or other of the post. It forms an anchorage for a strut or brace of 1-in. or 1½-in. by 4-in. board which is nailed to its 3-in. face and nailed also to the side of the

fence post. The top end of the strut is to be cut to a diagonal so that it fits against the pales or boards of the fence.

Assuming that the post—though loose, is not broken—is to be pulled upright by a rope looped around its upper part and tied to the stake. The rope must not be so placed as to interfere with the later fixing of the lower end of the brace. When the fence is being uprighted a helper should guide into the mortises the ends of the arris rails; the holes in posts should previously have been cleared of nails or dirt and the tenons also attended to in the same way. If the worker exerts a steady pull on the rope and his assistant at the same time pushes against the disconnected bay of fence, with an eye on the tenons, the latter can usually be made to go back into the post. To hold the loose bay a long piece of batten is temporarily spiked at one end to the arris rail and anchored at the other to a stake knocked in some way back for this purpose.

Now nail on brace to post of fence and, the rope holding the latter firm, attach other end of brace to the 3-in. by 2-in. post opposite. In windy weather an opportunity to do this must be seized between the gusts. Proceed in a similar way with other defective posts until all have been secured. A broken post must be supported by driving in close beside it a stake cut from 3 in. by 2 in. and reaching up some 2 ft. It is nailed to the sound base of fence below, if possible, and to the upper portion also. If the break in the post is below the ground, the stake can be nailed only to the top part of it. 3-in. by 2-in. timber is none too strong for mending the post, but stouter stakes would be difficult to drive in, and the slighter stuff answers for an emergency repair.

When a whole bay of the fence is blown out and lies on the ground, the tenons of the rails being broken off, the handyman should deal first with the posts as detailed above. Then, since the bay will probably have to be made up again with new rails, the ends of the latter are to be cut off flush with the end pales. A piece of batten is to be nailed to the face of the fence against and through to the rail, at top and bottom, projecting at both ends so as to afford a fixing to the posts. This having been done, the bay is uprighted, blocked up at the bottom to

bring it to the proper level, and nailed by the ends of the battens to the front of the posts.

Unless the fence in question faces a public path the owner will have to go on his neighbour's land to make this repair; but permission for this would scarcely be refused. Ask first, however, for this courtesy is due.

Making Good the Damage.—At an early opportunity the householder, if it is his responsibility, should take in hand the reinstatement of the fence in the proper manner. A temporary repair can be effected with any odds and ends of timber that are handy, but the task now described needs proper materials. Excavate around a defective post down to its butt; if this is sound the post can be left in, support being got from a short post of similar section—at least—concreted in alongside and behind the longer one.

The short post comes 2 ft. above ground and is tapered off to a long bevel where it ends. It is stood up in the hole and fastened temporarily to the fence post. Eight in. to a foot of concrete is shovelled into the hole and rammed well around posts, which are held from swaying during the setting by the temporary brace still in position. The tapered end of short post is to be nailed through to the back of taller post. When the concrete is hard the hole may be filled in to the top with earth. All timber used for this part of the work should be creosoted. It is worth while to remember that some timber merchants supply fencing and other timber ready creosoted, and the extra cost is negligible on 100-ft. lots.

When replacing a broken post with a new one, the latter is prepared in advance to the same dimensions, the mortises cut, top rounded or pointed, and so on. Dig out the butt of old post and remove any temporary support; the fence must be held away from the post to be dealt with, by struts connected to the arris rails. Now take off old post, being careful not to damage tenons of rails. Chop away the back of the post to free tenons, if necessary. Next try in new post for height and, this point being satisfactory, ease in the tenons at each side. The temporary struts may have to be slacked or taken down to facilitate this, but control of the fence must be maintained by ropes going to stakes. This is a job not to be done in gusty weather. Level up the post by a

piece or two of tile or similar material under its foot; or take out a little earth if necessary. Test it for uprightness with a plumb rule, or with a long spirit-level having a cross tube, and, this being assured, fill in the concrete. The new post and fence adjoining are to be stayed until all is safe and firm.

To replace a bay of the fence there are two ways; it may be stripped of its boards or pales and made up again, new arris rails being inserted into the posts at the time when the latter are being stiffened up and concreted in. Then the pales are nailed on to the new rails and any broken ones replaced. The second method is to take off the end boards or pales from the rails and form new tenons, reducing the length of the rails as little as possible. Against both of the existing posts on the inner side is planted a piece of 4 in. by 2 in. or 4 in. by 2½ in. long enough to take the mortises of the two or three rails of the fence. Holes are bored through these blocking-out timbers, and the wood chiselled out to form the mortises. Ensure that the tenons are shaped to fit these snugly.

It will be noticed that we have only 2 in. or a trifle more at each end to allow for the new tenons, and the work must be done accurately if it is not to result in failure. The actual length between posts can be ascertained by using measuring rods—two long pieces of thin batten that are overlapped lengthwise and slid along until they touch the posts at each end. Mark a line across both, and when they are brought together again at the mark the effective length can be measured. The rails are to be cut so that they just fit between the ends of the posts, and will thus project into the mortises in the new 4-in. by 2-in. timbers.

When the posts are being rectified the blocking-out pieces are to be fixed, but only one post can be concreted in and set. This method must be allowed to become firm; then we can fit in the bay of fencing and fix the second post in its hole. Carefully insert ends of rails into first post and temporarily block up and otherwise secure the fence—by struts each side. The second post being ready for concreting, it is pushed outwards just sufficiently to allow tenons to enter holes in 4-in. by 2-in. piece, and the fence is again pushed upright and stayed. Fill in concrete around post and its support in the manner

already described, and leave in a safe condition until the concrete has become hard.

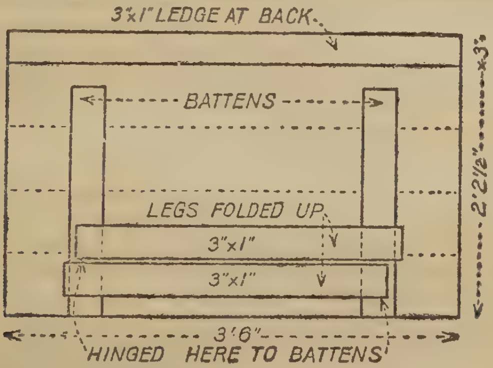
FLAP TABLE.—Many houses are built with a small kitchen that with difficulty accommodates a fair-sized table of the usual construction. A flap table that folds down when out of use is a great convenience in such circumstances. But, like all fitments of the sort, it must be stable and rigid when extended, and quite free from such vices as the tendency to double up when laden, or to give at the legs under slight pressure upon the latter.

The dimensions here given are taken from a table that was quite satisfactory in use and proved a boon to the housewife. It was 2 ft. 7¼ in. high to top surface, was 3 ft. 6 in. long and 2 ft. 2½ in. wide. Legs of 3 in. by 1 in. were hinged by 2½-in. butts to battens of the same section screwed on underneath. A ledge of 3 in. by 1 in. at the back was nailed on top of a wall plate cut from 6-in. by 1¼-in. board. The table-top was hinged by butts to the ledge.

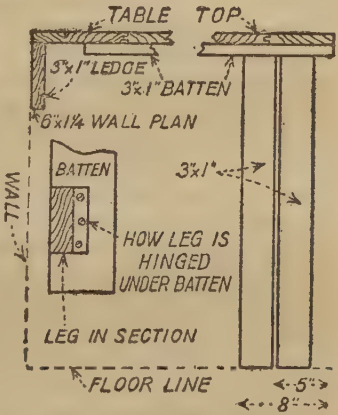
Begin the job by marking the position of the wall plate, 3 ft. 6 in. long, the top edge of which is to come 3 ft. ¼ in. from the floor. The latter may not be level, so that the plate must be adjusted to a true line by a spirit-level placed on its top edge while its position is marked. A helper will be needed for this operation. Mark for screw-holes in the plate and bore them for stout screws. Those known as "twelves" are suitable, and as they can be let into the plate a quarter of an inch, 2-in. screws will be just long enough. Use rawlplugs and procure a jumper bit of the correct gauge—12—with sufficient 1-in. fibre plugs for the job. Having bored the plate and countersunk the holes for screw heads, place the wood in position, again with the aid of an assistant, and mark through screw-holes with a fine centre-punch on to the wall. This will give a dot that indicates the centre of the hole to be drilled in wall, and is better than a bradawl, which might not be held truly central in the screw-hole.

Plugs of this type must be put in accurately so that point of screw engages with the hole in the plug, or they are useless. When a number of plugs has to be fixed it is therefore imperative that the job to be marked should be held steady and not allowed to slip; equally

necessary is it that the marking tool be large enough in its shank to fit closely in the hole in the job. Ensure this accuracy by a very careful choice of a centre-punch whose diameter and taper allow it to fit tightly enough



WORKING DRAWINGS FOR FLAP TABLE



and yet to project the bare amount needed for marking the wall. It must not be too tight, or difficulty will be experienced in withdrawing the tool.

After plugs have been fixed the plate is to be screwed up to wall. The latter may not be true, a detail that makes it wise to screw up the plate gradually, driving all the screws a few turns at a time and tightening them carefully. If the wall should be at all convex, an attempt to bring the plate close up at one point might exert such leverage that screws or even plugs would be drawn out at another. In the case of any pronounced convexity in the wall the plate ought to be

"scribed" to it—that is, hollowed at the point where the wall is uneven so as to allow the plate to go close to wall. This is a method used, for example, in fitting skirting boards.

The table-top is formed of T. and G. flooring, 1 in. thick (nominal), and the 3-in. wide ledge that goes on top edge of wall plate must be cut from similar stuff to ensure a flush joint at the hinged edge. Since the width of boards available locally may vary, we leave this detail to the worker himself, who should adjust the width of table-top so as to avoid ripping a board. It should not be much wider or narrower than 2 ft. 3 in., for sake of convenience in use. Cut off battens (3 in. by 1 in.) to 2 ft. long; they come flush with the front edge of table. Assemble the top boards and touch up the tongues or the shoulders of grooved edge as may be necessary to secure a close joint. The timber for this part of the work should be chosen especially for straightness and freedom from "winding," and ought not to need much in the way of trueing-up. If the latter is overdone it may ruin the joint instead of improving it. The unneeded groove and tongue are to be planed off, on front and back edges.

Have ready some sort of clamping device that will be wide enough to embrace the width of the table-top, glue the edges of joints and bring them together, place the work in the cramp, and squeeze up. Look now to ends of boards, and see that they are square, or that a line previously squared across the table is continuous—denoting that all boards are in the desired position. Increase the pressure, if necessary, to bring the joints closely together, and leave the top in a safe place until the next day. The boards for the top can be cut to 2 in. longer than the net length, and need not be cut to finished length until the work has been jointed and battened. The line referred to above is squared across near one end—or the boards if squarely cut are brought to a true square at this end—after the table-top is assembled and tried together; lay it in the cramp and squeeze the boards while marking. The front corners are to be rounded off with a compass saw later.

The next job is to screw on the bearers or battens to the table-top. They are located 6 in. from each end of

the table. At a point 5 in. back along the right-hand batten—measured from the front—is to be hinged the leg of 3-in. by 1-in. stuff. At the left-hand side the leg comes 3 in. nearer the front of the table, so that the legs may fold back clear of each other. One half of each hinge is recessed into the under side of batten; the other plate of the hinge is screwed to the inside of the leg, permitting the latter to fold inward. When the leg is swung outward it should be checked and held in a vertical position by the top end abutting against the under surface of its batten. The leg stands flush with the outside edge of the batten, and the recess for the hinge must be measured inward from the inner face of leg when the latter is in its proper position. The diagrams will make this clear. The legs must not be made too short in the first cutting; they may need a shaving taken off when the table-top is finally attached to its ledge.

The butts that hinge the top to the ledge are now to be fitted and fixed. The hinge opens downward, of course, and must be let into the ledge so that it brings the table to a close joint when the latter is level on its legs. Two small details remain to be dealt with: a small button to hold each leg to the batten when the flap is down; and some simple device to keep the legs apart at the proper span while the flap is up and the table is in use. The former are easily arranged. The latter can be a pair of bolts—one fixed to each leg—that are shot into holes bored a little way into floor boards at the correct location. An improvement would be the preparation of two square brass plates, each having a round bolt-hole and two screw-holes formed in them. These plates are let into the floor flush with the surface.

FLOORS, REPAIRING.—At some time or another the home mechanic may be called upon to take up defective flooring and replace it with new boards. We will describe the easiest way to carry out such a repair. Having taken up carpets and lino and pulled out any nails or tacks that come in the way of his operations, the boards are to be well swept. The run of the floor is of course at right-angles to the joists, and the location of the latter can be gauged by the position of the nails that fix the boards.

Examine the broken or otherwise defective boards and

decide how much of the floor will have to come up; bad boards must be cut at the joist nearest to the broken portion, except that if there are several in line the joint should be broken by taking some of them back to a farther joist (*see* Fig. 1). The cut is to be made along the inside edge of the joist at either side of the part to be taken up. We must locate the joist accurately by measuring from the nail heads, presuming these to be somewhere near the centre of its edge. Bore with a fine bradawl at 1¼–1½ in. from the nail; if the awl goes clean through we can be sure that we are in approximately the right spot, alongside the joist. Make a chalk line squarely across the boards that have to be taken up and thus indicate the position of joist.

With a brace and a ½-in. bit now bore a hole for the beginning of the saw-cut. It should come as close as possible to the joist. A keyhole saw is to be pushed through the hole, close up to joist, and used to cut a slot big enough to take a hand saw. The sawing of the board or boards is completed with the larger tool, taking short strokes, if the floor is one of an upper story, to avoid any damage to ceiling beneath. When the board or boards to be removed have been cut through at one end, the operation is repeated at the other until they are freed and can be lifted. Nails at any intervening joists are driven down with a hammer and a nail punch. If certain boards have to be cut back at another joist the position is measured for—easy now that some joists are exposed—entering holes bored here for the keyhole saw, and the job proceeded with as before.

Boards of correct width and thickness will have been procured for the replacement, and these can now be cut to the proper length. If the edge of the sawn boards is not true and square at the opening this must be rectified by using a keen chisel or a plane. There are two methods of securing a bearing for the ends of the new boards: we can affix pieces of 2-in. by 1½-in. deal to the sides of and flush with the joists at the opening, and nail new boards to these, or we can cut back the old boards sufficiently to get a bearing on the joist itself. If the first method is to be adopted, trim up the ends of boards to a square edge and fix on the fillets; then measure for the new board so that a tight fit will be secured. See that nails

in an intervening joist are punched down or drawn, and that any dirt on this joist or on the edges of adjoining boards is removed. The new board can then be tapped into place and nailed. The fillets must be securely nailed to joists, since the boards are supported by them alone at the ends.

If the ends of old boards are to be cut back, the first operation is to punch through the nails; next a cold chisel is driven between board and joist to raise the end, when a square and clean cut is to be made across the board with a back saw at the centre line of the joist. An allowance must be made for the slant of the board owing to wedge beneath it, and the end must be square and not splayed in its thickness. An inward splay would result in a gaping crack at the top surface. When fitting in new board, bore carefully with a bradawl for the nail-holes, as these must necessarily come close to the end in order to go securely into joist. Bore fresh holes similarly in the end of old board and nail it firmly.

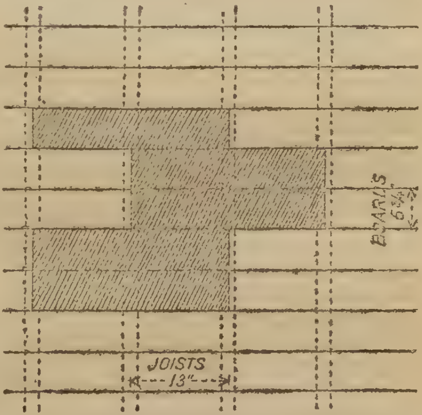


Fig. 1—REPAIRING DEFECTIVE FLOOR BOARDS

When the second method of fixing new boards—directly to joists—is to be employed, the old wood can be cut through in one operation with a back saw, if this is preferred. It is a more difficult job to execute neatly without necessitating trimming, and for that reason we have described the other method first. The boards are prised up at the joist next to the one where the cut is to come, after punching the nails through at this latter. A crowbar or a cold chisel can be used to lever up the

old board; another is then pushed in under on the joist to lift the floor board high enough for the saw-cut. Gas-fitters and electricians carry a short saw with a curved, convex blade especially for cutting floor board in such cases.

All nails used in fixing the new or old wood must be punched down below the surface, for the wood wears away much quicker than the nails and the latter in time are left projecting even though the heads at one time were well down. Where new wood comes alongside old, smooth the edges down with a sharp plane.

A quick and easy way of taking up a board for inspecting gas piping or electric wiring or for any like purpose is to bore holes at an angle near the presumed position of edge of joist, so that a keyhole saw can go through and just clear the joist. About 45° is the proper angle, and the saw is worked along at this inclination until the floor board has been cut through to its edge. The same thing is done at the opposite end of joist, and the piece of board is prised up and taken out. If it spans an intervening joist the nails will have to be punched through into this latter. When the board is to be put back the joins are secured by skew nailing through the splayed ends into the joists. Do not use this method, however, for a proper repair job, or for more than a single board.

When tongued-and-grooved flooring has to be dealt with, the matter is somewhat more difficult. The connecting tongue has to be sawn through along the crack between tops of boards, and at the joists must be severed with a chisel. The electrician uses a broad-bladed iron chisel for this purpose.

Recess for Door Mat.—It sometimes happens that a door sill at the front or back entrance to a house is too low to enable a thick fibre mat to be placed close to the door; the door will not clear the mat. One would think that a point like this would receive the builder's attention and that if the construction was unavoidable he would at least provide a well or a sunk recess for the mat. Nevertheless it is common knowledge that such a difficulty is met with. The task is not too difficult for the amateur to carry out with success. Mats are made in certain stock sizes, and the dimensions and thickness of the one

proposed to be used are to be noted. The joists are located as described earlier and the recess planned so as to take advantage of the lay of the boards and to avoid as much cutting as possible. A size of mat may be usable that will fit a recess extending between, say, four joists in its longest dimension, and over a number of whole boards in its shorter.

When the joists have been marked and the opening measured for, the floor boards are squared across for cutting close against them. A hole for the keyhole saw is bored as described earlier, and the cutting begun with this and completed with a larger saw. The nails in intervening joists having been punched down, the boards are

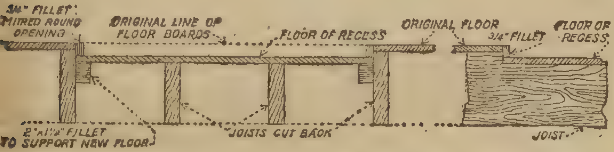


Fig. 2—RECESS FOR DOOR MAT, SHOWN IN SECTIONS

lifted. These joists are to be cut down on their edges to allow the floor of the recess to be lower than the surrounding surface. The height of the mat must be practically that of the floor, though it may be allowed to stand up very slightly if the door will permit.

Using a back saw with a wide blade, cut down on the joist to the required depth at each end, and also at each side of nails that were driven down to release boards. Chop away the wood round nails, taking care chisel blade does not run against the latter. This will enable the nail to be gripped by pincers and drawn. Next remove remainder of the waste wood to the proper depth. When other joists have been cut down in this way the new bearing surface is to be cleaned up and levelled with a plane—a bull-nose plane, if possessed, would come in handy for working up to the ends of the cut. The new floor boards will rest at their ends on fillets nailed to the joists. Fix these level with the cut edge of intermediate joists and carefully fit in floor boards. The fillets are taken 6 in. beyond the end of the opening each way, since the boards will to some extent underlap those

above. Should it be necessary to cut one of the old boards lengthwise to accommodate the mat, it may be best to take up this board and do the work at the bench. Unless it terminates at a near joist it will have to be cut out at one joist farther back than the opening on each side, and the loose ends of the remaining portion secured by fresh nails.

Make the cross cuts in the board first; then bore a hole for the small saw and start the lengthwise cut, completing this part of the operation with the hand saw. Be careful that the saw does not wander from the line; clean up the edge of the cut with a plane. Re-lay this board and nail down floor in the recess. A narrow board is best put elsewhere than at the edge. The new floor boards will extend some inches beneath those above at the long sides of the opening, so as to afford a support for the fillet later to be fixed, to hide the cut edges of old boards. This is of ¾-in. material, and it is mitred round inside the opening against the edge of the old boards, being nailed to the joists and to the edge of old boards. The fillet rests on the new flooring, and its width will depend on the depth of the recess. After all nails have been punched in, the floor of the recess and the mitred surround are finished off with a smoothing plane.

Should it prove impracticable to get the well to come close against a joist at one or both edges, on account of the awkward lay of the boards or the size of the doormat that must be used, the opening is cut to the proper size and the recessed flooring taken back farther to the nearest joist, where the supporting fillet is fixed. If the overhang is considerable a spacing slip of wood is inserted between old and new flooring, flush with the edge of top boards and nailed through to hold it in place. The mitred fillet will hide this and be nailed to the edge of top boards.

The accompanying diagram (Fig. 2) shows a recess cut down on joists spaced at 13 in. centres; both lengthwise and crosswise vertical sections are shown. In this case the joists were 2 in. wide and the opening after the ¾-in. fillet had been mitred round was 2 ft. 11½ in. long. The mat was 2 ft. 10 in. by 1 ft. 8 in.; the floor boards 5⅞ in. wide. The mat must be an easy fit at the start, for it spreads out with use.

GARDEN FRAME.—A one-light or two-light frame is a great boon to the amateur gardener. It will enable him to develop seedlings and very young plants despite unfavourable climatic conditions.

The would-be constructor should first procure two—or one, as the case may be—lights ready made. These can be bought unglazed, ready for the glass to be fixed by the purchaser, or are supplied glazed. The making of the lights themselves is a difficult task for the average amateur.

With the lights in hand, the handyman can determine the size of his erection, and the material of which it is to be built. Brick, concrete, or wood are suitable, the latter especially for a portable frame. A brick frame would be built of "half-brick" walls on a foundation of 6 in. of concrete. Instructions and diagrams for this kind of work are given in the article on BRICKWORK. The sides slope down to the front, which is a foot lower than the back. The top four or five courses of brickwork diminish in length to form this slope.

Provision must be made here for fixing a wooden plate of 2 in. by 2 in. at the outer edge of side walls, and for a similar one on top of front and back walls. These can be halved together, or mortised and tenoned. The front and back timbers are to be bevelled off to the proper pitch, to match that of the side walls. A guide is needed at the centre, and a slide upon which the lights rest. It consists of a length of inch board, 4 in. wide, that is let into the front and back plates flush with the surface. The guide is a piece of inch deal 2 in. wide; it is inserted in a shallow housing groove in the guide and is screwed to the latter.

Each of the side plates should have a groove worked in it lengthwise, and the centre slide also must be grooved on each side where the rail of the glazed frame will rest upon it. The purpose of the grooves is to conduct away water. The lights rest at the sides upon tne 2-in. by 2-in plates, so that these and the centre guide must be level, and parallel throughout their length. A suggested height for back and front, measured inclusive of plate, is 2 ft. 6 in. and 1 ft. 6 in. respectively, the frame measuring approximately 4 ft. 3 in. from back to front. This will give a slope sufficient to throw off rainwater

from the lights. Side guides of 3-in. by 1-in. stuff are fixed outside the wall plates at each end.

If a concrete frame were being erected, stakes of 2 in. by 2 in. would be driven in opposite each other on all four sides at the proper distance apart—say, 8 in. across from face to face—against which would rest the boards that formed the shuttering. Wall plates and a centre slide similar to those already described would be fixed. Breeze blocks are another material that might be used, set on a concrete foundation. With care, little trouble should be experienced in cutting the blocks of the side walls to the desired pitch.

Portable Frame.—This can be made up as a single-light or two-light frame. The sides are cut from suitable board jointed together and nailed to 2-in by 2-in. corner posts, the dimensions above given being suitable. Then the two ends are connected by nailing on the boards that form the back and front. The upper edge of the sides needs a water groove, and the centre guide and slide of a two-light frame would be similar to that described above. In the case of a two-light frame it is recommended that a 2-in. by 2-in. sill should form the base, the corner posts being tenoned into this at their lower ends. The covering should be of tongued-and-grooved floor boards 1 in. thick. Every part of the woodwork forming the box of the frame should be treated with creosote before or after assembly. The lights are to be primed and given two coats of lead paint. They should have a handle fixed at the top end of each.

GATE-LEG TABLE.—This is a useful and ornamental table, which gets its name from the swinging "gate" that supports the hinged leaf at either end. We shall require a set of turned or twisted oak legs and "swingers," comprising six of the former and two of the latter, also some 3 in. by $\frac{7}{8}$ in. and $1\frac{1}{2}$ in. by $\frac{7}{8}$ in. for the rails. The sets of legs, etc., can be purchased for about ten shillings or less. The oval table-top measures 3 ft. by 2 ft., and can be formed of $\frac{7}{8}$ in. by 12 in. boards. In this case there need be no joining of widths. The principles of construction will apply equally well to a somewhat larger table, but the one here described is not too difficult a job for the beginner.

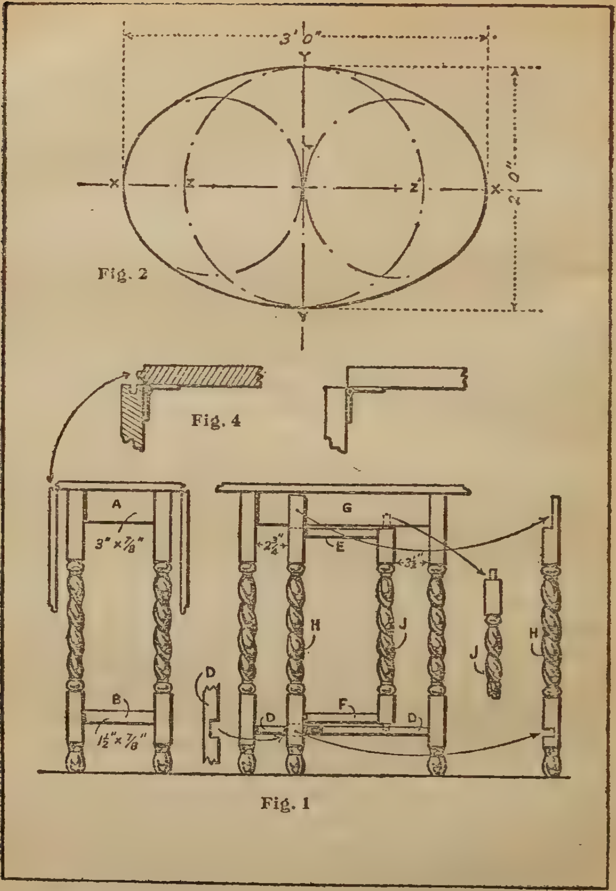
Commence by cutting the short rails for the ends of

the framework (Fig. 1, A and B). The dimensions of framework measured over legs are 10½ in. by 1 ft. 9 in. The rails are tenoned into the legs. The lower rail goes in on edge, as shown in diagram. The location depends on the position of the squared portion of legs; in the piece of furniture constructed for this article the twist commenced at 8 in. from floor level and extended to 1 ft. 9 in. The lower edge of rail B was 5 in. from floor, and that of top rail A was 2 ft. 1 in. from the same point. The height to top of legs was 2 ft. 8 in. When the two ends are ready, glue them and set in cramps.

The gates can next be taken in hand. They measure 11¾ in. over leg and swinger. The top rail E and the lower rail F have to clear the corresponding rails D and G of the framework, and therefore come inside them. The top of leg H of the gate is cut back, and the bottom of the same leg is notched, so that the leg can close in upon the rails D and G. The rail D also is notched where the leg comes over it, in the manner of a cross-lap or halved joint. Thus the gate closes up flush with the table legs. The rails G must be set back enough to permit the top of leg H of the gate—which is cut back to half its thickness—to close in flush with the adjacent leg of framework. The swinger J is to be cut off to the necessary length and bored for the dowels that act as pivots for the top and bottom. The rails G and D of framework require corresponding holes into which these dowels will fit. Note that the long lower rails of frame and both rails of gate are tenoned in on the flat, unlike those of the ends, which go in on edge. Glue up and cramp the gates and put aside till safe to handle.

Before connecting the ends of framework by fixing the long rails, the dowels of the gates must be inserted in the holes prepared in rails D and G. Make sure the rails are square and the legs truly vertical. If a pair of large enough cramps is available, clamp the framework when it has been glued and tested. Failing sash cramps, the worker can use corner blocks and a length of cord. The latter is tied round the framework, over the blocks, and tightened by twisting a stick in the loop, after the fashion of a tourniquet.

Note that the gate is not fixed central between the legs of the framework; the swinger J is 3½ in. from right-hand



WORKING DRAWINGS OF GATE-LEG TABLE

leg as we face the table (*see* diagram), and the leg of gate H is 2¾ in. from the left-hand leg of table. These measurements are taken between adjacent faces of the legs in question. The rails of gate, when the latter is

closed, are separated from the rails G and D of framework by about $\frac{1}{8}$ in. In marking for the joints of rails and legs or swingers, care must be taken that enough clearance is permitted for the swinger, and that the squares and twists on the latter will come even with those on the legs of gate and framework. Stops for the gates, to prevent them opening too far, are made of short pieces of dowel inserted into the under surface of the folding leaves of table at the proper location.

The legs are turned up from $1\frac{1}{2}$-in. oak, but $1\frac{3}{8}$-in. stuff would do. The rails must not be slighter than those specified, and the joints with legs need to be accurately cut and tightly fitted. A simple mould is to be worked around the edge of the table-top—except, of course, at the hinging edges. This may be begun with a rebate plane and finished with a smoothing plane and chisels. A rounded edge might be substituted, if desired, omitting the quirk. Before, however, anything of this nature is tackled we must strike the ellipse that marks out the shape of the table-top.

Lay on the bench in proper position the three 12-in. by 2-ft. 3-in. boards from which the top is cut (*see* Fig. 2). Drive in a brad at either end to hold them up closely together. Square a line (X) across the boards lengthwise at the centre and another (Y) at right-angles. Measure off along the length of the table a distance equal to the radius—half the breadth—at each side of the centre line (Z and Z′). Drive in at these last points two panel pins and connect them by a piece of thin twine of such a length that the point of a pencil placed in the loop will mark the wood at the point Y—the radius of the ellipse at this point. Hold the pencil upright and press its point tightly on the wood, allowing the pencil to move outwards as far as the loop will allow, and in this way trace out the curve of the upper half of the ellipse. By transferring the pencil to the other side of the twine, the loop being now downwards, the lower half of the oval can be indicated. In order to get a concentric line, on the face of the table, to mark the position of the quirk of the moulded edge, the twine can be shortened enough to indicate the lesser radius, and this marked in a similar manner.

The leaves are attached with back-flap hinges. The

hinging edges of leaves and centre are capable of treatment in several different ways. Plain square edges (*see* Fig. 3)—provided for by our dimensions—look quite all right when the table is extended, but are somewhat ugly and amateurish in appearance when the leaf is folded down. The most satisfactory plan for the beginner, perhaps, is to form tongues on the edges of the centre board, and grooves to match on the edges of the leaves (*see* Fig. 4). A pair of planes for this work, if not already in the tool collection, would be an investment that might well be considered by the home mechanic; there are a hundred and one jobs that could be done more easily or with better finish by using such tools. A makeshift would be to plough a groove in all edges and to insert a feather of oak in either edges of the centre board. It must not be overlooked that the working of a tongue on the edges of the centre board reduces its effective breadth by the thickness of the wood removed to form the shoulders.

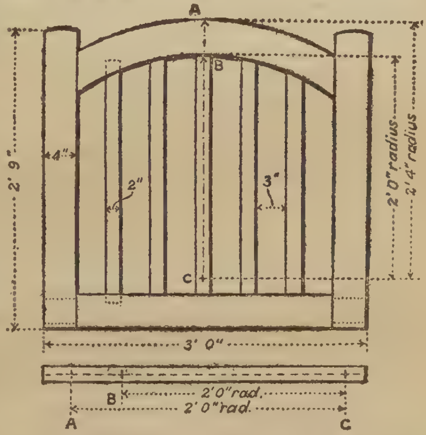
All these operations on the top having been completed, the hinges are to be fitted and the surface cleaned up. The centre section is fixed to the rails of the framework by screws inserted in gouged-out pockets formed in the rails. Test the gates and locate the stops for them in leaves. Make sure also that the leaves work satisfactorily. When these details are correct the table may be polished.

We recommend the worker to examine closely a table similar to the one to be made. Doubtful points will thus be cleared up and details of construction will be grasped. Probably the leaves will be furnished with what is called a rule-joint moulding—the best and neatest method, but one not suited for the novice to adopt.

GATES.—In the article on Fences are given hints for making simple gates for a garden fence or a screen. Here we describe the making of an entrance gate of a strong and pleasing form. It makes no great demand upon the skill of the amateur joiner, who if he can make a sound mortise and tenon joint will be able to turn out a creditable and workmanlike article. A gate is one of those jobs that are quite futile unless carried out with good materials in a proper manner. Recently we had occasion to try and doctor up one that had stood barely three

years' wear; it was not unlike the one illustrated, though its method of making was vastly inferior. It looked all right at the beginning, and the rails appeared to be mortised and tenoned to the stiles in the orthodox manner; the pales, too, seemed to be tenoned into the rails, both of which were rectangular.

Upon later inspection, after both stiles had come away from the rails, it turned out that these were stub-tenoned, a loose piece fitting into mortises in both rail and stile. Since the tenon was not pinned to either member it was a wonder the gate had held together so long. So much for the main constructional members. The pales were not tenoned, but were merely let into a groove in both rails, with spacing pieces fixed in the groove between them to simulate a proper mortised and tenoned job.



ENTRANCE GATE WITH GAUGE FOR ARC

Any gate that has not got an intermediate rail should have an extra strong top and bottom rail, for otherwise there is little to prevent sagging or "lozenging." These remarks are to warn the handyman of what he may suspect in cheap gates that are mass produced—and to make it clear that good workmanship and materials are essential to a satisfactory job in this as in all other work about the house.

Dimensions.—The gate illustrated is 3 ft. wide, and 2 ft. 9 in. high to top of posts. The shaped top rail is an inch higher; it is cut from a 9-in. plank, 2 in. thick. The frame is cut from 4-in. by 2-in. stuff (nominal), and the five pales from 2-in. by 1-in. timber. It is imperative

that all the wood should be sound and well seasoned, free from shakes or winds, knots or other defects.

The top rail may be taken in hand first; the plank from which it is cut must be long enough to furnish the tenons that go through the stiles. Plane both sides and test it for thickness to ensure that in this respect it will be like the other rail and the stiles. These latter, being of prepared—planed—timber, will be slightly less than the nominal section. Lay the 9-in. by 2-in. plank on the bench and secure it by cramps, or by brads at its edges. Mark the central point in its length and square a line across its breadth. Prolong this line along a piece of smooth board tacked on the bench and packed up level with the rail; at a distance of 2 ft. and 2. ft. 4 in. from the top edge of rail mark the points for the two radii of the curve—outer and inner edges.

A 3-ft. long piece of ¾-in. by 1½-in. deal is to be marked with a central lengthwise line (use the marking gauge for this), and points indicated at 3 in., 2 ft. 3 in., and 2 ft. 7 in. from one end. Into this piece of wood, which is to form the beam of a compass, we insert a fine nail at the 3 in. point; the nail is to protrude and be tapped into the board on which we have already marked the radii of our curves. At each of the two farther points a hole is to be bored to take a round pencil, which must fit tightly. Sharpen the pencil and push it into the farthest hole, A—2 ft. 7 in. from the end of beam. Now press the pencil point down gently on the surface of rail, and swing the beam so that a line is marked on the rail to denote the curved outer edge of the latter. Remove pencil, insert it in the hole B, 4 in. nearer the compass pivot, and trace the outline of the inner curved edge of rail. Unfasten the rail, reverse it, keeping same edge to the top, and trace first the inner and then the outer curves on the face also.

The curves are cut with a compass saw, and the top edge of rail rounded off. The tenons to rails may now be marked and cut. The top edge of the lower rail is to be bevelled slightly, the central portion where the pales are inserted being left square. When the mortise and tenon joints to stiles have been made and tried in, the mortises for the pales can be proceeded with. In locating the mortises in the top rail a little difficulty may be

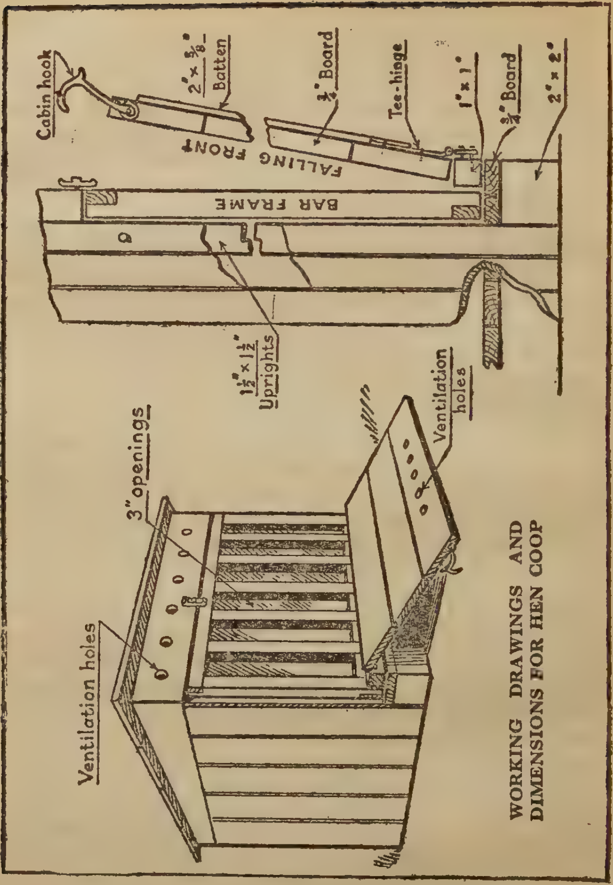
caused by the concave lower edge; a line is to be gauged on the face of the rail at the correct distance in from the edge for the mortise depth, and another ruled square across the rail from stile to stile. This can be marked when the rails are being tried in the stiles. From this latter line the position of the pales is indicated by vertical lines at right angles—a set-square could be used for marking them. Otherwise, the setting out and cutting of these mortises follows the usual lines.

The pales vary in length, the longest being the middle one. They are cut from 1-in. by 2-in. stuff and are spaced 3 in. apart. When the gate is ready finally to assemble, all the joints should receive a coat of lead paint before putting them together. Those of the rails with stiles are pinned with pieces of dowel. In boring for these, make sure that the shoulders of the rails are close up to the stiles. Pales are to be inserted first in the lower rail, after this has been connected loosely to the stiles, and the top rail then eased on. Test the frame for squareness, and drive home the members with gentle blows of a mallet, a piece of waste wood being interposed to prevent injury to the face of the work.

Two—or better three—coats of lead paint should follow after the gate has been cleaned up and sand-papered. Hinges and a latch are to be fitted to choice; these should be good-quality ones, which are only a little more costly than poor ones and save much trouble and annoyance later. A spring also may be called for to cause the gate to close of itself. If our instructions have been followed and the work properly done the home mechanic will have an entrance gate that will do him credit and last for many years.

HEN COOP, HOW TO MAKE.—For the poultry-keeper in the small way, who wishes to rear 40 or 50 pullets, the broody hen is difficult to beat for hatching purposes. Small incubators at the best are delicate contrivances, but the broody hen does her work without fuss or anxiety if she is comfortably housed.

A convenient floor-space for the broody coop is 2 ft. by 2 ft. A solid floor of ¾-in matching is nailed down on to three 2-in. by 2-in battens. Eighteen inches is the usual height for a coop, but 24 in. of head room in front is better, since the hen can then be lifted up off the eggs,



WORKING DRAWINGS AND DIMENSIONS FOR HEN COOP

if required, without danger of dislodging the eggs. Make the front uprights therefore of 1½-in. by 1½-in. quartering, 28 in. high in front and 19 in. at the back—thus giving 24 in. and 15 in. interior head room respectively. These are halved on to the base at the sides, and are set back

2 in. in front to allow for the bar frame which prevents egress of the hen but allows the chicks to come and go.

The uprights at each side are secured by top cross-pieces halved into them. To get the correct angle, hold the top piece beside the uprights—making sure they are truly positioned—and mark off, afterwards cutting inside the pencil lines. The sides and back are then matchboarded, the sides protruding just about 1 in. to cover the ends of the bar frame. Across the front at the top, nail a piece of 1-in. board, 6 in. wide, bored with six 1-in. holes for ventilation.

The bar frame is a simple affair of nominal 1-in. square material, halved at the corners. Laths 1½ in. wide and spaced at intervals of about 3 in. are nailed into shallow slots cut for them in the top and bottom rails of the frame.

A strip of 1 in. by 1 in. is nailed on to the floor along the front, so leaving a trough which will receive the bar frame with sufficient play to avoid jamming in wet weather.

The fall front is made of ¾-in. matchboarding, nailed on to battens and attached by hinges to the outside of the 1-in. strip just mentioned. It is made tall enough to reach the edge of the top bar, and comes flush with the matching at the sides; it is secured in the closed position by hooks at the sides.

The roof is matchboarded, allowing 4 in. overhang in front, 2 in. at back and 1 in. at sides. A coat of creosote and tar, inside and outside, and felting on the roof complete the job.

JOINTS.—A knowledge of the commoner joints and an ability to make them properly is necessary to everyone who practises woodworking, since there is hardly an article consisting of more than a single piece of timber in which one or another of the various kinds of joints is not met with.

From the amateur's point of view, the requirements of a satisfactory joint may be summed up in four words: strength, accuracy, neatness and simplicity. Treating these qualities in turn, it is first of all essential that the joint employed shall be adequate to resist the strain imposed upon it, without giving way or becoming weakened; and, in addition, it must be so arranged and cut

as to take as little as possible from the strength of the material in which it is formed. It must be accurately fashioned, so that the article, when put together, shall be of the correct size and shape. For instance, if the sides of a dovetailed box are measured to length and then the pins of the dovetail are made too long, the side of the article will be shortened accordingly when the latter is assembled; while if the haunched mortise at the corner of a panelled door is cut inaccurately so that the stile and rail do not lie in the same plane, the door will be "in winding" and will be ruined for its purpose.

Thirdly, joints must be as neat and as inconspicuous as possible, consistent with strength. On the finished surface the glue uniting the two members should appear only as a thin line. Projecting wood should be planed off neatly and no open gaps or crevices should be visible. In cabinet-making and other fine work, secret or concealed joints should be employed wherever it is possible to do so. Moreover, a joint must be appropriate to the article in which it is to be used. Thus, a heavy keyed tenon joint securing the rail of a small occasional table would look out of place and altogether absurd.

With regard to simplicity, the amateur would be well advised—at least, until he has gained experience—to undertake only those joints that lie well within his powers, leaving the more complicated forms to the professional woodworker. Indeed, the simpler joints are often the strongest and the most suitable to the work in hand, while the more involved types—such as the mitred dovetail and mitred joint—are often employed merely for their inconspicuousness and in order to impart a superior appearance to the work.

Joints can be divided roughly into three classes, according to the functions which they are called upon to perform:

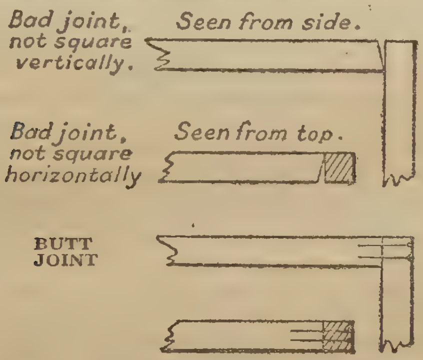
(1) For adding to the length of timbers. The chief kinds used are the butt, halved, lapped and scrafed joints.

(2) For increasing the width of timbers, such as in panelled work, matchboarding, flooring, table-tops, etc.; they include the glued butt joint (often reinforced with battens across the back of the work), tongued-and-grooved joints, dowelling and slot-screwing.

(3) For joining two pieces of wood at an angle, or two

pieces that lie in different planes. The commonest forms used for these purposes comprise the great majority of joints, and include all varieties of mortise and tenon, mitre, dovetail, housed, keyed, bridled, lapped and rebated joints.

The most important of the joints listed above, as well as their more common variations, are described in the following pages, to which the reader is referred. Full instructions are provided for setting out and making the joints. *See also* Dovetails *and* Mortise and Tenon.



Butt Joint.—This joint is made by placing the two members together and gluing and nailing them in position. Though somewhat despised by the adept worker, it will often be found useful, especially in rough or temporary work. An essential for a sound and strong joint is that the parts must meet squarely and fit tightly together. In fixing rails or studs in quartering by this method, be sure that the ends are cut off square in both directions (*see* sketch). Holes should be bored through one member where possible, and just started in the other, so that nails will not go askew or split the timber.

Joints may be butted and dowelled, and these will be found dealt with under the heading Dowels and Dowelling.

Halved Joint.—This joint is used extensively in making framework, light doors, screens, and similar

work where two pieces have to be joined immovably at a right-angle without the strength of a mortise and tenon joint being called for, or where the wood is not thick enough to allow the latter joint to be made satisfactorily. In principle, each of the two pieces of wood forming the joint is rebated, or recessed, to half its thickness. Each piece then fits exactly into the other, and the thickness of the joint is equal to the thickness of each single member comprising it. There are several simple modifications of the halved joint, but since the principle of construction is the same for all of them, only one form—the angle-halved joint—will be described in detail. It is used typically for making a right-angle joint at the corner of a rectangular frame.

Each piece of wood must be planed to exact size and equal thickness, and the ends must be perfectly square. Set the cutting gauge to the width of one piece and with it mark off a line across the width of the other piece, parallel to the end. Repeat this operation on the other piece of wood. Now reset the gauge to half the thickness of the wood, and from the face side of each piece mark a line across the end grain and as far down each side as the line that has already been marked across the width of the wood.

Deepen the line that was marked out first by drawing the edge of a chisel across it, guiding the tool with a straight-edge; and then remove a narrow ridge of wood from the waste by drawing the chisel across once more, turning the hand obliquely towards the end of the board. Now make a cut with a tenon saw as far as the second gauged line, but no farther. Lastly, remove the waste wood from the end grain by chopping it out with a chisel. When each piece of wood has been treated alike, fit the two halves of the joint together, and test them for a perfect fit. If any easing is required, this can be done by paring with the chisel. If the joint is accurate, both pieces of wood should lie in one plane, and the shoulders of the rebate should make a close fit. The joint should then be glued and cramped up tightly to dry. Additional security can be imparted by driving in screws or nails.

Housed Joint.—There are many applications of this form of construction, among the most common being the fixing of the divisions of pigeon-holes, stationery racks,

etc., to the horizontal boards or to the sides, or the fixing of book-shelves. The joint consists of a groove cut across the grain of one piece of wood and wide enough to receive the square and unworked end of the other piece.

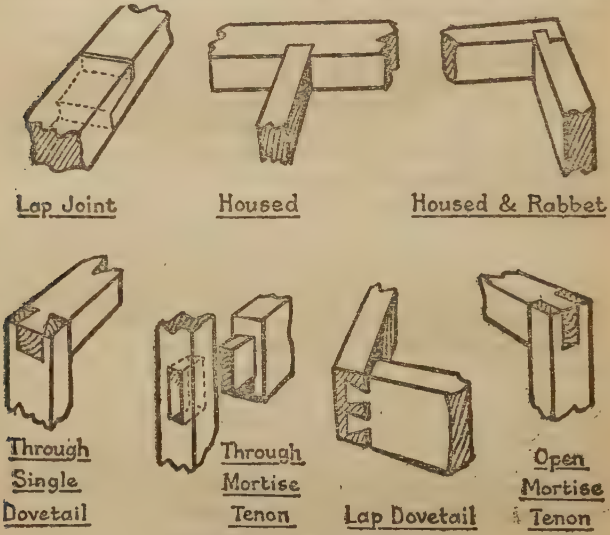
Plane up the stuff, and having decided upon the position of the groove, or housing, lay the stock of the try square along one side of the board and mark off with the blade two parallel lines across the breadth of the board and as far apart as the thickness of the other piece of wood that is to fit into the housing. These lines should be marked out with the scriber or chisel, and care must be taken that they are not too far apart or the joint will be loose when it is assembled. Mark the position of the groove on both edges also of the board. If the housing is to be near the end of a board, it may be possible to set it out with the marking gauge.

Next set the gauge to the depth of the housing, and mark this off along each edge of the board, between the two parallel lines already set out. Then with a chisel make a slight groove or shoulder in the waste wood along each of the parallel lines, using a straight-edge as a guide, and with a tenon saw cut down in these grooves as far as the depth lines on the edges of the board, being careful to keep the blade of the saw vertical. Remove the waste wood lying between the two cuts with a chisel, and, if necessary, level off the bottom with a router. The end of the other board, which should have been squared off accurately, can then be inserted. It can be glued in place, and, if necessary, further secured with nails driven from the other face of the grooved board.

The plain housed joint which we have described is, of course, visible from the front of the work, but greater neatness can be obtained by the use of the *stopped housing*, which is invisible from the front of the job. In this joint the groove does not extend all the way across the breadth of the wood, and to enable the front edge of the other piece of wood to fit over the stopped part of the housing, a small rebate must be cut in it. In the stopped housing, the tenon saw cannot be used freely across the wood in cutting down the sides of the groove, and before the sawing is begun, a little of the waste wood should be cut away with the chisel immediately adjacent to the stopped part of the housing, so as to provide a

free space for the end teeth of the saw. Since it is useless to gauge a depth line on the edge at the stopped side of the housing, care must be taken to keep the saw quite level, otherwise the bottom of the groove will slope from end to end.

Sawing the rebate in the other piece of wood should present no difficulties. The main thing is to set it out accurately, and to keep the saw within the waste, so that



JOINTS IN WOODWORK

the shoulder may fit closely against the stopped part of the housing, without showing an unsightly gap.

A plain housed joint enables the shelf or partition to be inserted either from the front or rear, but the stopped housing permits it to be pushed into place from the back only. A variation of the joint is the dovetail housing. This has a dovetail cut on the edge of the shelf, and a groove of corresponding shape cut in the vertical member. It has the advantage, common to all dovetailed joints, of resisting pull in the principal direction. The shelf must fit accurately in the groove, and is slid into place between

the verticals. A vertical can be dovetail-housed into horizontal members, of course, and the principal members of a set of pigeon holes would be thus jointed in order to give strength to the fixture.

Lapped Joint.—This is one of the simplest joints used in woodwork, and in its most elementary form two members are merely overlapped and nailed or screwed together. We describe a more useful form in which one member is cut away for part of its thickness to form a shoulder. This joint is really a simplification of the ordinary halved joint, since only one of the two pieces of wood forming the joint is cut, or rebated, while the other piece of wood, which fits into the rebate, is left quite square. This joint forms a very convenient alternative to the dovetail joint where the strength or appearance of the article does not demand a dovetail, or where the skill of the worker does not extend to making the latter joint. It is useful in assembling boxes, the backs of drawers, and light framework that is not required to withstand a pulling strain.

Only one of the two pieces of wood is to be set out and worked. Having decided upon the thickness of the piece of wood that is to be lapped over the plain half of the joint (usually half, or a little less than half, the total thickness of the wood), set the cutting gauge to this thickness and run a line along the edge of the part to be rebated and also a little way round each side. Now reset the gauge to the depth of the rebate, which will be equal to the thickness of the wood forming the plain half of the joint, and run a line across the inner face of the board in which the rebate is to be cut. This line will cross the grain at right angles. Deepen this line by drawing a chisel across it, guiding the tool with a straight-edge. Again draw the chisel over the line, this time with the handle of the tool turned obliquely towards the edge of the board. If properly carried out, this operation should leave a furrow all the way along the line, in the waste wood, which will be very useful in guiding the tenon saw accurately. Insert the saw and cut down evenly until the bottom of the saw kerf is level with the line that was gauged first of all in the edge of the wood. On no account cut deeper than this line, for this would seriously weaken the joint.

Now cramp the work firmly to the top of the bench and proceed to cut out the waste wood with a chisel, using a mallet to drive it, and cutting into the end grain of the wood, along the line that was gauged first. Trim up the lap perfectly square and flat with the chisel alone, using a paring action. The rebate is now completed, and the joint can be assembled. A lapped joint is usually glued; it can be strengthened by driving oval wire nails through the lap of the rebate and into the end grain of the plain piece of wood forming the other half of the joint.

The middle lap joint occurs where the end of one piece of timber is rebated so as to overlap another piece at a point along the length of the latter between the two ends, the two pieces of timber generally meeting at a right-angle. This joint is extensively used in light framing of all kinds. Its method of construction presents no essential points of difference from that of the angle-lapped joint already described, and it can be either nailed or screwed and glued. A neater finish is obtained by chamfering off the arris of the plain side of the lap.

In the cross-lap joint, the two pieces of timber intersect one another in the form of a cross. The peculiarity of this joint lies in the fact that the lap is formed by a groove cut in the overlapping member, instead of an open rebate. This groove must be set out so that its width is equal to that of the intersecting piece of wood. The sides of the groove are cut down with the tenon saw, and the waste removed with the chisel. The groove should not be made too deep, or a weakness of the joint will result. The edges of the plain piece of wood must fit tightly against the shoulders of the groove, without any lateral play.

It will be noted that the overlapping member stands up above the intersecting one, since the latter is left full size in its sectional area. If the two surfaces are to be brought together flush, *each* of the crossing timbers must be grooved. If they are both of the same thickness, they must be halved, when we get the halved cross-lap joint. This has been described in the article on FENCES. It is used in framing-up sections of an outhouse, for example, that are to be lined with matching or weatherboarding. Though it stiffens the frame, the joint has an inherent weakness in that half the material is removed from each

member at the crossing. None the less it is a useful joint in many different forms of light work, and when the principal joints are mortised and tenoned there is nothing against its use in intersecting and subsidiary members of a framing.

Mitre Joint.—The mitre joint is very commonly used when the ends of two pieces of wood have to be joined together at an angle; and when the latter is a right-angle, the joint is said to be a *true* mitre. Examples of true mitres are afforded by the corner joints of picture-frames and by the junction of the architrave moulding at the top of a door-casing. Mitres at other angles can be seen in the joints of the framing of bay-windows and in the joints of wooden curtain-poles for the same windows. In all cases, the chief distinction of a mitre joint is that the face of each half of the joint is cut at an angle which is equal to half the angle formed by the whole joint. Thus, in the case of a true mitre joint, where the angle contains 90°, the inner angle of each face of the joint must contain 45°; while, if the complete mitre contained 120°, the line of the joint would divide it into two angles, each of which would contain 60°. The necessity for this detail of construction will be apparent if we consider a picture-frame, cut out of moulding and mitred together at the corners. If the mitres are accurately cut, every projection and depression in the moulding of one side will fit exactly against the corresponding projection or depression of the adjacent side, and for this accuracy to be observed, the line of the joint must bisect the angle.

Precision in cutting mitres is obtainable by the use of several alternative appliances. These are the mitre-box, the mitre-block and mitre templates, which will now be described.

In its simplest form, the mitre-box resembles a long box of hard wood, such as beech, without ends or lid. It thus forms a channel in which the strip of wood to be cut can be placed. A saw kerf is made right through both sides of the box and at right-angles to their faces, and on each side of this kerf another one is made at an angle of 45° to the sides of the box. If a tenon saw is inserted in either of these kerfs it will cut at an angle of 45° across a piece of wood that has been laid truly in the channel of the mitre-box. When purchased the box may

have the sawcuts shallower than the depth of the trough. They become deepened in using the mitre-box. The central saw kerf, placed at a right-angle, is useful for squaring off the ends of pieces of wood and for cutting up a length of material into rails, etc.

The mitre-block resembles a mitre-box with only one side. It is useful for cutting small mouldings and similar work, but for all-round purposes the mitre-box is the more useful article, especially in view of the double support given to the blade of the saw by the two sides of the box.

Mitre templates are usually made of brass or iron, and consist roughly of a triangular frame, of which two of the angles are cut at 45°. The template is laid upon the work and the angle is marked out with a pencil or scriber, the joint being cut afterwards with a saw. For some kinds of work templates are a great convenience, but they are inferior for general purposes to the mitre-box or block, which not only determines the angle but also serves to guide the saw at the same time.

Mitre joints that meet at angles other than those provided for by the mitre-box or block can be set out in the following manner. First determine the size of the required angle, by means of the bevel, or in any other way that is convenient. Bisect this angle and set the bevel to the number of degrees thus obtained. Mark out the angle of each side of the joint in turn, and cut the mitre by guiding the tenon along a straight-edge held to the line that has been marked on each half of the joint.

The greater part of the mitreing work which the amateur is likely to undertake can be assembled straight away, without further finishing, but for very fine work, such as the corners of picture-frames and mirrors, it is usually advisable to trim up the faces of the joint with a sharp plane. For this purpose the work is laid in a mitre shooting-board, and the shooting plane or jack plane is passed along the edge. In this case, the measurements of the joint should be left rather full, and the surplus planed off in very thin shavings until it has been sufficiently reduced.

A mitre joint should be glued together, and if it is not expected to stand any great strain, it can be further secured by nails or screws driven in from the sides so as

to cross the line of the joint at right angles. Greater strength can be secured, however, by dowelling one-half of the joint to the other, for which operation the reader is referred to the article DOWELS AND DOWELLING. An alternative method, useful if one side of the work is to be concealed, is to cut a dovetail channel across the joint at a right-angle with the centre line, and then drive in a hardwood key, cut to fit the recess and well glued. The projecting ends of the key should be pared off flush with the edges of the joint. Another method of keying a mitre joint is by inserting slips of veneer. Cramp up the assembled joint in the bench screw, when the glue has dried, and make one or more saw kerfs into the outside corner, and penetrating equally into both halves of the joint. These saw cuts, if there be more than one, should not be made parallel with one another, but should incline slightly towards one another as they proceed deeper into the wood; hence as each kerf is made, the top of the saw should incline towards the outer face of the wood. This gives a slight dovetail effect, which increases the strength of the joint. Now insert a strip of veneer, well glued, into each saw kerf, so that the grain of the veneer runs across the joint. Clean up the ends flush with the surface of the work.

Corner cramps are a great help in the assembling of mitre joints. For further information the reader is referred to the article on PICTURE-FRAMING. *See also* DOVETAILS, DOWELLING, *and* MORTISE AND TENON.

KITCHEN TABLE.—If the maker is content with plain legs tapered off from 3-in. by 3-in. deal, this piece of furniture can be made up very inexpensively indeed. Turned legs of 2½-in. or 3-in. section cost from five to six shillings a set and give a more ornamental appearance to the table, but it is merely a question of taste as to which kind of leg is utilized.

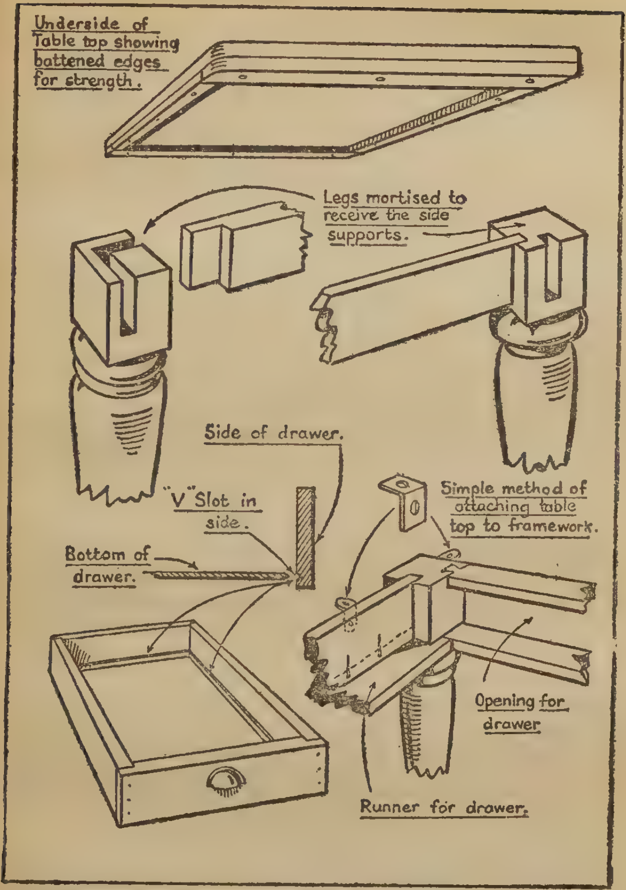
If square-section legs are going to be used the home mechanic will begin by cutting off 3-ft. lengths of clean, sound 3-in. by 3-in. stuff. Put them each in the bench vice in turn and work the taper with a jack plane. A slight taper improves the appearance of the legs; it should begin 6 in. below the top of the leg, leaving a square shoulder above to receive the mortised and tenoned rails.

Dimensions may be varied to suit the fancy of the constructor. Those specified below are a guide, being measured from a home-made table; length over legs, 3 ft. 7 in.; width over legs, 2 ft. 5½ in.; top, 4 ft. by 2 ft. 10 in. The standard height for legs is 2 ft. 4 in., and the top is of ⅞-in. boards, making the total height just under 2 ft. 5 in. The long rails and the short rail at the end without the drawer are jointed to the legs by bareface tenons, a haunch-tenon being the best for this job. The ends of adjacent tenons are mitred to meet in the centre. A simpler way of joining rails to legs is by slot mortises meeting in the angle and coming to the top of the leg. The rail is shouldered at its lower part, the shoulder butting against the leg.

At the drawer end of the table we have to provide two rails. The upper one is fixed to the leg by a single dovetail at each end. Note that here the adjacent long rails would have to be fixed by close mortises unless top drawer-rail also was mortised in on its edge. The lower drawer-rail is mortised and tenoned to the leg. All these constructional details are dealt with in the accompanying diagrams. The two ends are made up first, glued and cramped. When ready the framework is assembled by fitting in and gluing the long rails.

The table-top is formed of 4 boards each 8½ in. wide. Tongued-and-grooved ⅞-in. stuff is the best for this, but plain-edged boards can be used and rubbed glue joints formed. In any case the joints must be close ones; the boards, after trying together, are to be glued up and placed in cramps to bring them together. Screw on battens in such a way that they will not interfere with the drawer or with the fixing of the top to table; we assume that the top will be fastened by screws inserted from below in screw-pockets formed in the rails. Another and more satisfactory method is to use a number of buttons that work in a groove formed in the inside face of the rails and are screwed to the table-top. The top is free to expand or shrink, so that the groove-and-button fixing is undoubtedly the best. If this latter method were adopted the rails, of course, would need to be grooved before assembling the framework of the table.

The corners of the table-top are rounded off, and the sharp arris removed with a plane. If in spite of careful



WORKING DRAWINGS OF A KITCHEN TABLE

preparation and clamping there are any crevices between boards, they can be filled with plastic wood. The top surface is cleaned up with a smoothing plane and rubbed down with sandpaper. Beneath each rail, except the

drawer-rails, is glued and tacked a ½-in. beaded slip to make a pleasing finish.

The drawer, if made in the conventional manner, demands some skill in dovetailing. The sides of the drawer are lap-dovetailed to the front so that they show only at the sides. The latter and the front rail have a groove worked in their lower edge to take the plywood bottom of the drawer. The back of drawer is housed into the sides, or may be rebated into the latter; it comes above the bottom board, which slides beneath it into grooves in sides and front. The bottom board is left long and projects slightly beyond the back, and is fastened by a couple of tacks. If later shrinkage makes this necessary, it can be pushed in farther. The front of the drawer will need a "pull" or handle of some sort.

A runner for the drawer is fixed to each of the long rails, lined up with the surface of the drawer bearer rail; upon it blocks are glued at such a location that they form a guide for the sides of the drawer, and prevent this from rocking sideways. Above the drawer a "kicker" rail is fixed to prevent the drawer rising up as it is pulled out.

Detailed instructions for cutting dovetails and for making a drawer are to be found in the articles DOVETAILS *and* DRAWER.

LEAN-TO SHEDS OR SHELTERS.—A lean-to roof can be attached to the house wall with or without side or front walls. It can thus form either an open shelter or a shed. Such an arrangement will often be very useful as a protection from rain outside french folding-doors, or as a shed for household and gardening utensils, or even as a coal or wood store. The back of the house is generally chosen as a site; but in houses possessing a side entrance door which is not used very much, this location can be conveniently used, the door permitting an entry direct from the house.

Roof Only.—In all these erections the key to strength and therefore the member which may cause trouble is the wall-plate, shown at Fig. 1, A. This holds the roof back to the wall, and any negligence in fixing it will recoil on the head of the householder.

Having determined the height of the front or lowest part of the roof—7 ft. is recommended—at a distance of 7 ft. from the wall erect two posts, and a header. Up to

10 ft. long and 7 ft. wide from the wall the sizes of timber given in the diagram may be used. The posts must be creosoted or preserved in some way and entered firmly into the ground about 1 ft. 6 in. deep. They are to be made exactly vertical with the use of a plumb-line. They can be wedged into their holes with stones or pieces of old brick, well driven down; a binding mixture of rather thin cement and sand is then poured into the hole. (*See* the article on CONCRETE).

Across the top of the two posts and exactly horizontal is to be fixed with halved joints a length of 4 in. by 2 in. on edge (Fig. 1, B). At a point precisely horizontal to this front header and level with the top edge, mark the wall at each end and measure about 1 ft. 9 in. above. This is where the top edge of the wall-plate is to come; the point can be moved a little up or down if a more convenient line can thus be found. A guide for the line of this plate is furnished by parallel joints in the brickwork. Note that, as mentioned later, a steeper pitch must be provided if weather-boarding is to be used as a roof covering.

The end positions of the wall-plate are found, and squareness ensured, by equalizing the distance between the diagonals as at Fig. 1, D, with stout string stretched from Y1 and Y2 to X1 and X2.

Wall-plate.—This is a length of 4 in. by 2 in. and must be bored to take the shanks of at least seven 5-in. screws (12 gauge). Offer up the plate in its position—it must be the same length as the front header overall—and mark distinctly through the two end holes as shown at C. Remove plate and, with a No. 12 rawlplug drill, enter two No. 12 rawlplugs equal in length to the difference between the plate and the screws. To these screw up the plate loosely, making sure to enter the screws into the centres of the plugs or they will not be secure. Then mark the other holes on the wall face and dead central, take down the plate again and rawlplug the remaining five holes. The plate, first to be cut with saw and chisel to house the rafters, as shown at C, can now be permanently fixed. Its screws must be well driven home. Some old paint at the back will help to preserve it. Creosote should not be used if painting is contemplated later.

Rafters.—The cross-rails or rafters come next; quartering of 2-in. by 2-in. or 3-in. by 2-in. section may be used, and the slots cut in C must tally with the section chosen. Three rafters are needed, one at each end and one in the middle. Lay the lengths endwise to the wall, at the proper location on header and plate and scribe a line parallel to the wall on the top ends. Square

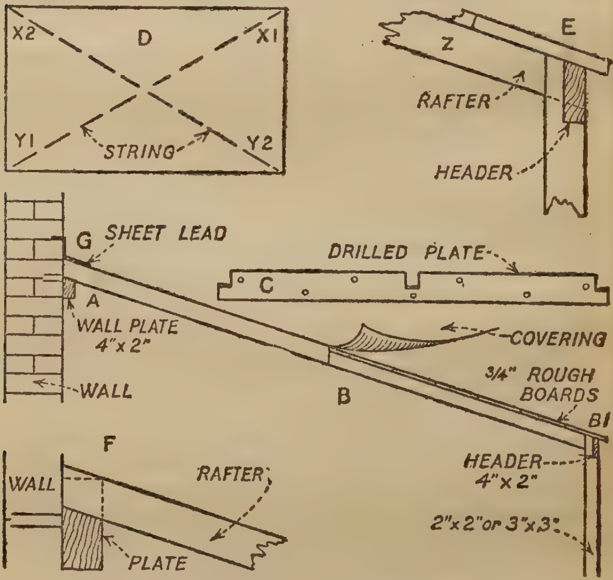


Fig. 1—DETAILS OF ROOF OVER LEAN-TO

off the top and bottom faces and cut to the marks. Again lay them on, when they should touch the wall nicely at the top ends. Lay them square, using the "diagonal" method shown at Fig. 1, D, and mark and cut the header to allow the top surface of the rafters to drop in tightly, level with the top of the header at its front edge. The joints are shown at E. The ends Z may be left on or cut off as desired. The top joints are as at F.

The rafters are to be well screwed to the wall-plate

and header with 3½-in. screws, which have been dipped in paint before fixing. Sawn or planed boards are then laid parallel to the wall. They should be quite dry when laid or they will shrink and look ugly from underneath as well as allowing the roof covering, if soft, to sag in the cracks. The last board laid—over the header—must project over the front about 1 in., as at B1 (Fig. 1). The

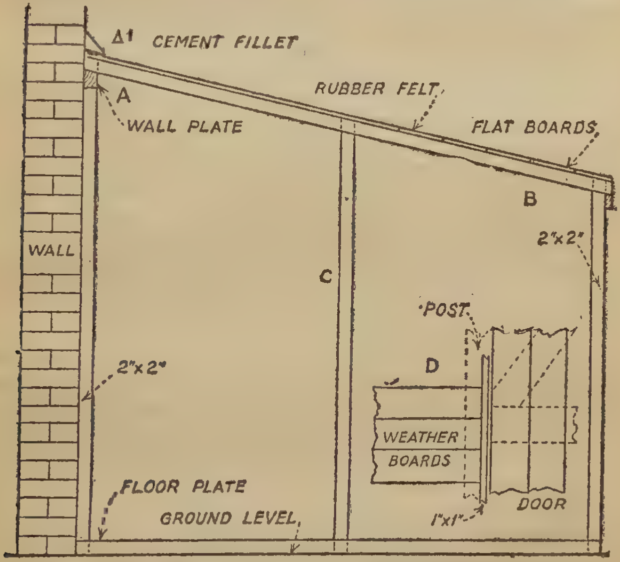


Fig. 2—DETAILS OF LEAN-TO SHED

boards are to be well nailed at each intersection of rafter, header, or plate, using 2-in. French nails.

Roof Covering.—The covering material is next to be laid. Rubberized covering needs to be left a few days in the warm sun to stretch, or it will wrinkle up after nailing. Should it be intended to use weather-boards for the roof, the slope ought to be increased by at least 6 in. or 8 in. more than the 1 ft. 9 in. as specified above. In the case of rubberized roofing or felt, the covering is commenced at the front, and 4-in. or 5-in. lap allowed at

each joint. The top can be finished off neatly and soundly by cutting a piece of sheet lead 9 in. wide to lay on top of the covering; it goes up the wall face and is inserted in the pointing or joint of the brickwork (G, Fig. 1). A cheaper job is a cement fillet, shown at Fig. 2, A1. At the ends the covering is carried over the edge and galvanized nails fix it to the end rafters. A gutter may be fixed, if necessary, and temporary enclosure can be effected with eyeleted canvas hung on hooks all round.

Lean-to Shed.—The same roof may be completely enclosed by permanent walls of timber framework lined with asbestos cement sheeting, weather-boarding, or matchboarding. If the latter be used, the framework should be horizontal as much as possible and the boards vertical, while with the other forms the framing is perpendicular. We will deal with weather boards. Fix securely with rawlplugs a 2-in. by 2-in. upright on the wall in line with the end of the wall-plate, and lay and fix a floor-plate (*see* Fig. 2). Cut and joint in the strongest manner possible a post, as at C, Fig. 2. All end faces of the frame should be in alignment with each other.

Commencing at the bottom the weather-boards can be fixed. The door must be arranged for, and be placed at one end or at the front. The end is better, as there is more height, and no gutter to interfere with the frame. The front is the best location for windows, and better light will be obtained there. Where a door comes, the ends of the weather-boards are terminated in the middle of the post and a piece of 1-in. batten is nailed at the square-cut ends of the boards to form a neat finish (Fig. 2, D). Posts must be inserted for windows, and a drip sill provided beneath them to carry off rain.

Probably the most satisfactory way for the amateur to deal with the windows is to build-in a complete frame with casements. At his local merchant's he will get a choice of stock sizes, and can arrange his framing to suit the one chosen.

Windows should be placed also at the ends, if possible, to avoid dark corners. Here the worker can utilize the end posts, and save time and timber. Hints on glazing window-frames are given in the article on GLASS.

MORTISE AND TENON.—This is one of the commonest of all joints in woodwork, as it is also one

of the strongest and most important. It is used in assembling both light and heavy framework, in cabinet work and furniture making, in fastening the rails of panelled doors to the stiles, and in other varieties of work that are too numerous to mention. The essential principle of this joint is that a projecting tongue, or tenon, is sawn in the end of one piece of wood, to be inserted into a rectangular slot, or mortise, that has been chiselled in the thickness of the other piece, so that the shoulder of the tenon abuts closely against the face side of the slotted piece. There are several common variations of the mortise and tenon joint, but the one that we shall describe first, as being the most generally characteristic, is the through mortise—so called because the mortise penetrates right through the thickness of the wood, so that the end of the tenon is visible on the other side.

The width of a mortise—and consequently of the tenon as well—should usually not exceed one-third of the width of the wood in which it is cut. Therefore, a mortise chisel must first of all be selected whose width is as nearly as possible one-third as wide as the wood. Having determined where the ends—or narrower sides—of the mortise are to come, mark two lines to represent them across the working face of the wood. Prolong these lines by means of the try-square down each side of the wood, and join the ends of these side lines with two lines across the fourth side. Now take the mortise gauge—this tool is essential for accurate work—and set the two steel points as far apart as the width of the chisel that has been selected. Next, adjust the fence of the gauge so that when it is drawn along the face side of the work, between the two lines that already mark the ends of the mortise, the space marked out by the two points will fall in the centre of the width, with an equal space on either side. The rectangular space that has thus been set out represents the waste wood, which is to be removed with the chisel. When the face side has been set out, turn the wood over and set out corresponding marks on the reverse side.

Chiselling should be commenced in the middle of the waste and extend evenly towards each end. Having fixed the work firmly, face upwards, to the top of the bench, set the chisel upright across the grain of the wood,

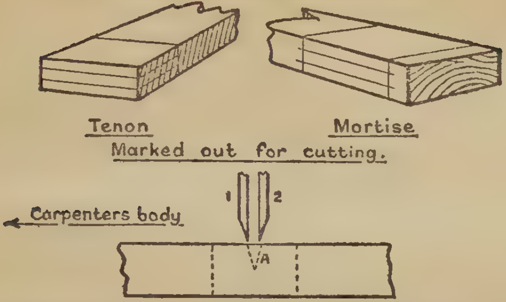
so that the bevelled side of its edge faces the worker, and drive it in a little way with the mallet. Withdraw the tool, reverse it, and drive it in again about ¼ in. or less from the other side of the first cut; then lever up the waste lying between the two chisel cuts. Reverse the chisel once more and make another cut close to the first that was made. Proceed alternately in this fashion until the centre of the mortise has been opened up making all the cuts across the grain throughout. The ends of the mortise are approached with the bevel of the chisel facing the centre of the waste, and the final cut on each gauge line must be made with the tool held dead upright. Only half the depth of the mortise should be cut from the face side; the work is then turned over, and the same operation is repeated on the reverse side.

On no account must a mortise be cut right though from one side, since it would be almost impossible to come out quite accurately on the reverse. When the mortise has been completely cut through, any slight irregularities in its sides can be removed by hand paring with a firmer chisel. In large mortises, the labour of chiselling can be considerably reduced by boring out the bulk of the waste with a brace and bit; the diameter of the bit should be slightly less than the width of the mortise, and it must not encroach beyond the gauge marks. As in chiselling, the boring out should be done half-way through from each side.

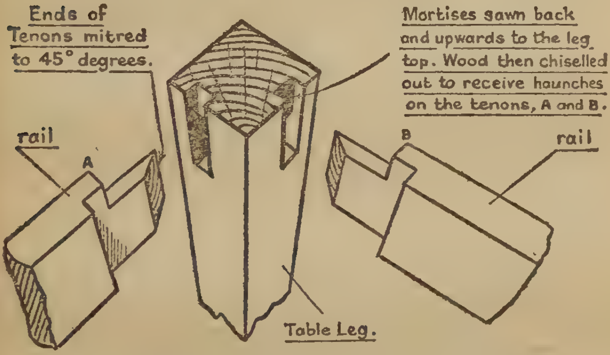
The tenon should now be set out, using the same adjustment of the gauge as was used for the mortise. The thickness of the tenon should be set out from the face of the wood that is to lie in the same plane as the face from which the mortise was set out, so that any slight inaccuracy may be the same in both members of the joint, which, when the work is assembled, will ensure an even and unbroken surface. The tenon should also be set out rather on the long side, so that it will project slightly through the mortise when assembled, and can be planed flush.

Cramp the piece to be tenoned upright in the bench vice, and saw down the vertical lines, along the grain, with a tenon saw, keeping the latter within the waste. Then, cramping the wood flat on the bench, saw squarely down the shoulder lines, taking care not to go beyond the

Through Mortise and Tenon.



Cutting Mortise. 1. First cut of Mortise Chisel.
2. Chisel reversed to cut out chip "A".



Haunched Mortise & Tenon Joint.

lines already sawn. Knock the joint together lightly with a mallet; it should make a tight fit, but should not require force to assemble it. If the tenon has been sawn too full, it may be reduced on the faces with a flat file; a chisel should not be used, since it leaves the wood too smooth for the glue to get a good grip. Assembling the

joint will be made easier by lightly chamfering off the arrises of the *end* of the tenon, the latter having been made long enough to project slightly. When the joint has been glued up, the projecting part is planed down flush with the mortised part.

A very strong joint can be obtained by wedging the tenon from the reverse side, after it has been inserted in the mortise. For wedging, the mortise must be given somewhat of a dovetail shape, being slightly longer in each direction on the reverse side than on the side next to the shoulder of the tenon. In outside wedging, thin wedges are simply glued and driven in with a mallet between the ends of the tenon and those of the mortise. In inside wedging, either a single saw-cut is made in the centre of the end of the tenon, or else a cut is made at a little distance from each extremity (but not too near the edge); wedges are then glued and driven in as before. When the glue has set, the projecting ends of the wedges are trimmed off flush.

The stopped mortise and tenon is used where the end of the tenon is to be concealed. It is similar to the through mortise, except that the recess does not penetrate right through the work, and thus can only be chopped out from one side. The bulk of the waste can be bored out with the brace and bit; the latter should be fitted with a depth gauge, in order to keep the depth of the mortise uniform.

A very neat but powerful joint can be made by fox-wedging a stopped tenon. The mortise is cut in a dovetail shape, the narrower side being on the inside face. The inclination given to the ends of the mortise should not be too great, however, or the joint will be weak. The tenon is made as broad as the narrower side of the mortise, and a saw kerf is made towards each of its extremities. Narrow wedges are then lightly inserted in the kerfs, and the whole joint is glued. When the tenon is driven home, the wedges press against the bottom of the mortise and are forced right into the saw kerfs in the tenon, which is thus expanded to grip the ends of the mortise. Care must be taken to make the wedges just the right length.

The open mortise and tenon is used for joining the extremities of two pieces of wood at an angle, where

greater strength is desired than would be provided by the angle-lap joint. The mortise is open at one end, and thus can be partly sawn out, care being taken to keep the tenon saw just inside the waste. The chopping out should be done from both sides, as in the case of the through mortise.

The haunched mortise and tenon is used at corners, especially those of panelled doors and similar work, where as much strength as possible has to be imparted to the joint without making the mortise too large. In the square variety of this joint, the mortise after proceeding for a short distance into the wood, has its width reduced on one side. The tenon had part of its width reduced to correspond, and the joint consists, as it were, of a large and a small mortise and tenon side by side. In making the mortise, the broader part is first cut down to the required depth with the end of the tenon saw, and then the waste is chopped out of the narrower part. The tenon presents no points of difficulty; the setting out must be done very accurately, however, or the work may be in winding when the joint is assembled.

In the sloping, or bevelled, haunched mortise and tenon the haunch—or broad part of the tenon—is cut away at an angle as far as the shoulder, and the mortise must be made to correspond. For extra strength, haunched tenons may be wedged, or, if they do not penetrate right through the wood, fox-wedged as already described.

A bare-faced tenon has one shoulder only; it is used when the wood in which it is cut is thinner than the mortised piece, or when the wood in which the plain side of the tenon is situated is to be boarded over.

The stub tenon is a short stopped tenon, and is used for framing where no great strength is required. It enters for only a short distance into the mortised piece.

Double mortise and tenon joints are employed when the wood to be joined is very wide or thick, or where considerable strength is necessary, in preference to using a single large tenon joint. A familiar example of this joint is in joining the middle rail of a panelled door to the stiles.

A mortise and tenon joint is often pinned, in addition to, or instead of, gluing. In simple pinning, the joint should be forced tightly together with a cramp and a

hole bored right through both flanks of the mortise as well as through the tenon; the hole should not be too near the edge of the wood. A wooden pin, slightly larger than the hole and with a pointed end, is then driven in tightly and trimmed off on each side of the work. An alternative method is provided by draw-boring, used for through mortise and tenon joints. The tenon is made long enough to project 1 in. on the other side of the mortise, and a hole is bored through the projecting part. The tenon is withdrawn from the mortise, and a hole for the wood pin is bored right through both flanks of the mortise. The tenon is re-inserted, and is marked for boring a little nearer the shoulder than the holes through the mortise itself. When the tenon has been bored, it is inserted once more, and a smooth, round, tapering piece of steel, called a draw-borer, is passed through the hole in the projecting end of the tenon, so as to strain the latter tight in the mortise. When it is drawn up sufficiently for the holes through the joint to coincide, a wooden pin is driven through. Finally, the projecting end of the mortise and also those of the pin are sawn off flush and smoothed.

In the diagram to illustrate the article on KITCHEN TABLE is shown a slot-mortised joint, and also a haunched-tenon joint. Other forms are illustrated in the article on JOINTS.

PANELLING.—This article describes simple methods of producing on a wall surface an appearance simulating that of framed panelling. The making and fixing of the latter is a task for the accomplished woodworker, and we do not propose to deal with it here. Panelling may extend from the skirting to the frieze-rail or picture-rail, approximately 6 ft. 9 in. above the floor level, or may consist merely of a dado. The novice may well begin with the latter, which extends to a height of 3 ft. 6 in. to 4 ft. from the floor line.

The skirting board and rail are to be removed, since new ones will have to be fixed in keeping with the new work. A method of making up panels, which gives the closest approach to real framed work, is to use grooved rails and stiles, into which $\frac{3}{16}$-in. plywood is inserted to form the panels. Suitably grooved stuff, in oak or some other hardwood, can be purchased, or would be machined

to order at many timber yards. It should be 1½ in. to 1¾ in. wide and ¾ in. thick. The outside rails and verticals need to be grooved only on the inner edge, but the remaining ones will be grooved on both edges.

The dado should first be planned out on paper, to some convenient scale, the spacing of the framing being indicated by lines at the centres lengthwise or vertically of the rails or stiles, as the case may be. Joints at the intersections are made by an easy method: a stub tenon is cut on the end of one member and fits into the existing groove in the other member. For example, the tail which fits on top of the skirting is tenoned to the vertical at either end—against a return wall at one side and against the door architrave at the other side. The other longitudinal at the top of the dado is secured to the vertical members in a similar fashion. All intervening verticals are stub-tenoned to both upper and lower rails. A quadrant (¼-round) bead or hollow moulding of suitable section is glued and pinned to edge of rails and stiles close against the face of the panels afterwards.

The framing members rest upon light battens previously attached firmly to the wall in precisely the location that the framework itself will occupy. Thus the battens are of 1½-in. by ⅝-in. deal, spaced according to the prearranged dimensions and location of the panels. After the plan has been drawn, the principal lines are to be transferred to the wall by snapping chalk lines to indicate the top edge of the upper and lower long rails. By measurement along the top the centre lines of the intersecting verticals are found and marked from top rail to lower rail. These lines are a guide for fixing the deal "grounds" or battens; these will later be hidden by the grooved moulding and the panels.

The method of fixing the deal battens will depend upon the wall surface behind. This part of the work must be properly dealt with, since any unevenness, looseness or other defects would prevent the proper completion of the panelling. The grounds, when fixed, should be a replica of the framing that will be fixed to them. Fine screws of a suitable length are to be used to attach the grooved framing to the grounds. Since the panels enter the grooves on all edges, they must be

nearly twice the depth of the groove longer in each direction than the distance between the faces of the framing members. In the case of a dado, the panel will reach from top rail to lower rail; when panelling extends up to the frieze-rail, two or even three panels will usually intervene, necessitating one—or two as the case may be—long rails between. A single panel can be used if preferred, extending from frieze rail to skirting.

If the grounds have been accurately spaced and carefully fixed, there should be little difficulty in attaching the rails and stiles and in inserting the panels as the job proceeds. The rails are to run the whole length of the wall, and the verticals likewise to go entirely from skirting to frieze.

The plywood in ash—$\frac{3}{16}$ in. thick—costs about 5d. per square foot. Birch is a little cheaper. Oak plywood, either with a figure or a common grain, costs considerably more—say 7d. to 9d. per square foot. No one who considered cheapness first would adopt this method of decorating a room or a corridor, but even if the dearer woods are used, the cost is very low for the result attained. Ash is the best wood if a low cost is desirable; when judiciously stained, it gives an appearance resembling that of oak. It is hazardous to buy cheap laminated wood, and the worker should be chary of purchasing odd or job lots of plywood. Unsuspected defects may manifest themselves later when the job has been completed, with troublesome and disappointing consequences.

Imitation Panelling.—Quite a pleasing appearance is presented by a surface treated in the simple manner now to be described. Rough grounds are to be attached to the wall, after a careful dimensioned drawing has been made, in the manner mentioned earlier. To the battens large sheets of the plywood are now tacked with panel pins, so that the entire surface is covered. Upon this surface, strips of $1\frac{1}{2}$-in. by $\frac{3}{8}$-in. oak are next "planted" to give the effect of framed-up panels. After the plywood has been nailed down to the deal battens the position of the horizontals and verticals is carefully and accurately to be indicated by chalk lines, so that the oak strips can be placed properly above the deal battens, now hidden by the plywood. Since the oak strips are

merely butted together at the intersections, square and cleanly cut ends are essential.

When laying out a system of grounds, bear in mind the stock dimensions in which the selected plywood is obtainable or has been purchased; cutting and waste will then be reduced to the bare minimum. The various grades are sold in differing sizes.

PICTURE-RAIL AND PLATE-SHELF.—Unless a picture-rail is perfectly level and neatly jointed at the corners it will prove a constant eyesore, therefore a spirit-level should always be used when such a rail is being fitted. Choose the most important or most conspicuous wall of the room to begin with, such as that immediately facing the door or containing the fireplace. Measure the distance from the ceiling at which it is desired to fix the rail, and find a line of mortar in the wall, as is described in the article on CHAIR RAIL. Adjust the rail by means of the spirit-level and nail it in the line of mortar with cut nails, although plugging the wall and using screws is preferable. In any case, the method of fixing is similar to that employed in the article just referred to. Then proceed with the next largest wall, taking care to get the rail on the same line as the one already fixed. The short return walls, if any, can be dealt with last of all, since any slight departure from a true level that may occur in fitting in the final sections of rail will be less apparent if the sections are short than it would be if they were long.

Mitre joints should be used for the angles where the sections meet. Angles other than right-angles should be measured with the bevel and bisected, and then each end of the rail forming the corner should be cut to the half-angle. A tool, called an angle divider, can be obtained for bisecting angles for this kind of job; and it can also be used for setting out four-, six- or eight-sided work, but the amateur can dispense with it if he uses the bevel accurately.

A narrow shelf for supporting ornamental plates that are propped up against the cornice can be easily screwed to the top of the picture-rail. This shelving can be purchased ready made by the yard, either in oak or deal; a suitable thickness is $\frac{5}{8}$ in. The shelving should not be too wide—say $2\frac{1}{4}$ in.—and it should be furnished with a

groove about $\frac{1}{2}$ in. from the front edge and sloping off towards the back of the shelf. The shelf is screwed to the rail with long, thin screws, spaced about 15 in. apart; the corners are mitred and either tongued together, as described in the article on MITRE JOINT, or secured with thin oval nails. One disadvantage of a plate-shelf fixed in this manner, however, is that the picture-hooks must be placed in position before the shelf is screwed down, a recess being cut in the latter to accommodate the top of each hook—which, of course, prevents the hooks being moved about at will.

Where a wall is not provided with a picture-rail, a flat rail of $\frac{5}{8}$-in. deal or oak can be fitted according to the instructions given in the article on CHAIR RAIL; and the plate-shelf, already grooved, can be screwed or nailed to the upper edge of this rail. If desired, the two pieces of wood can be fitted together before attaching to the wall; and afterwards, ornamental blocks, sawn out of flat-topped moulding, are nailed along the rail at regular intervals apart, so as to conceal the heads of the nails or screws by means of which the rail is attached to the wall. Thin oval nails are used for attaching the blocks; they are punched below the surface and the holes are filled in with plastic wood. The whole fitting is then stained or painted.

The following are the dimensions of a typical rail- and plate-shelf of this type. White deal $\frac{5}{8}$ in. thick is used for both rail and shelf. The former measures $2\frac{1}{2}$ in. in width, and is fixed to the wall at intervals of 15 in. The plate-shelf is $3\frac{1}{4}$ in. wide, and has a sloping groove $\frac{5}{8}$ in. from its front edge. The blocks are 2 in. wide and $1\frac{3}{4}$ in. high, and at the top project $1\frac{1}{2}$ in.

POULTRY HOUSE, HOW TO BUILD.—A type of chicken house which has become increasingly popular of late years for a breeding-pen or a laying-house is the fold with a wired-in run. The house is mounted on wheels, so that the birds may have an open-air run for scratching and grass eating and can be moved easily to unsoiled ground when the run gets foul. In ideal conditions, where there is room, the fold is moved daily. The fold described below is suitable for 12 to 15 hens and a cock, or for 15 to 20 pullets.

The house itself is 6 ft. wide, and 5 ft. high and 5 ft.

long. To it is attached as a continuation a wired-in run 12 ft. long. The floor of the house is slatted and there are entrance-doors to house and run.

Timber.—For the framework of the structure, good clean timber is required, particularly in the case of the 17-ft. longitudinal pieces. Any pieces with large knots, "shakes" or other defects should be rejected. The bottom frame is formed of 3 in. by 1½ in. on the ground and 2 in. by 1½ in. above, mortised into 2-in. by 2-in. posts at corners in such a way as to leave the outsides flush all round (Fig. 1).

Fig. 1.

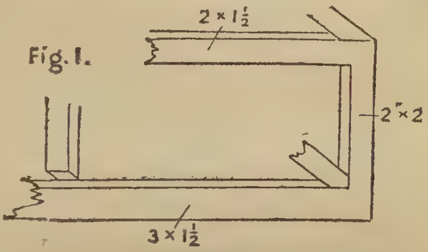
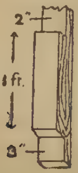


FIG. 1—DIMENSIONS FOR BOTTOM FRAME

The distance between the inside of upper and lower rail is 1 ft. The height of the framework and posts therefore will be 1 ft. 5 in. (Fig. 2). To support the upper rail, uprights 2 in. by 2 in. are inserted. These are cut away at top and bottom to a depth of 2 in. and 3 in. respectively and nailed on to the inside of the rails to avoid cutting into the main framework. The first pair of uprights—at 5 ft.—mark the end of the house. The second pair, 5 ft. farther on, mark the position of the door of the run; and the third pair, 3 ft. from the other end of the run, help to support the shelter over the feeding-trough.

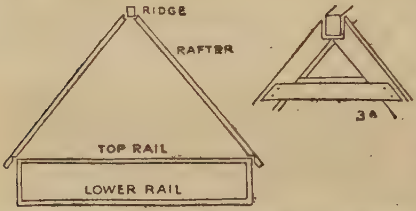
Fig. 2.



To support the ridge piece, at least six pairs of rafters 5 ft. 6 in. long must be cut and nailed firmly to ridge and to upper rails; at each end of the frame the rafters are flush with the ends. Leave the ridge about ¾ in. clear at top, to allow room for matchboarding (Figs. 3 and 3A). The third pair of rafters is positioned 5 ft. from the end rail, to carry the matchboarding of the house. A piece of 2 in. by 1½ in. is to be halved in to the rafters of the house on one side to carry the flap-door in the roof, for access

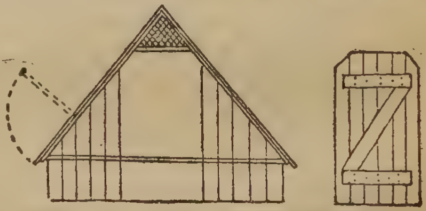
to the laying-boxes. These will be mentioned later. The positioning of the rafters is shown in Fig. 8.

The framework of the floor is completed by halving two pieces of 2 in. by $1\frac{1}{2}$ in. into the bottom rail, nailing them firmly in both directions. One piece is to be located 2 ft. 4 in. from the end, and the other about 4 ft. 10 in., just inside the rafter. Across these and the end rail the slatted floor is laid, consisting of tiling battens 1 in. by $\frac{3}{4}$ in. spaced 1 in. apart. As a gauge, to keep the interval uniform, a short piece of batten is slipped between the batten already nailed-in and the next, and withdrawn after the fresh batten has been nailed down. The front door-posts of 2 in. by $1\frac{1}{2}$ in. are now halved into rafters, top rail and bottom rail, 2 ft. apart, and matchboards nailed on from sides to the midline on the posts, leaving 1 in. clear on each post to receive the overlap of the door.



Figs. 3 and 3a—DETAILS OF FRAMEWORK

The upper rail, if it is found inconvenient to step over it, may then be cut away between the door-posts (Fig. 4).



Figs. 4 and 4a—FRONT OF HOUSE

Make the door (Fig. 4A) 2 in. wider than the inside measurements of the door-posts, so that it will butt against and lap over posts. It is shaped at the shoulders to fit against the rafters, as shown. When completed and fitted, it is to be hung. Fix 1-in. mesh wire netting on the inside of the triangular opening at the top above the door.

The back of the house is similarly fitted with two

uprights, and between the left-hand uprights of front and back ends a partition of stout plywood is to be run from the floor to within 6 in. of the roof, to shut off the laying-boxes from the rest of the house. On the same side of the house halve a piece of 2 in. by $1\frac{1}{2}$ in. into the house rafters, 18 in. above the upper rail. This will serve to take the roof-matching, and also provide for hanging a flap-door giving access to the nest-boxes. The back of the house can now be matchboarded and two entrances left, one to the nest-boxes and one to the house (*see* Fig. 5). These are opened and closed at will by two drop shutters running in grooves, and kept open by a loop and a nail. A stop, 1 in. square, is run along the bottom of the house outside the match-boarding.

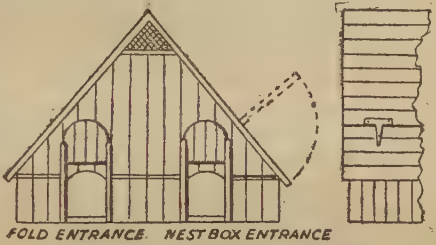


Fig. 5—BACK OF HOUSE LEADING TO RUN

The sides of the house up to the lower rail are now to be match-boarded, and also the side of the roof, opposite to the enclosure for the laying-boxes, the matching running horizontally. The top board on each side of the ridge should be bevelled to fit snugly to the ridge. The other side of the roof is to be matchboarded down to the cross-rail, leaving 1 in. of the latter bare. To this rail is

Fig. 6—DIAGRAM SHOWING SPACE FOR FOOD AND WATER TROUGHS

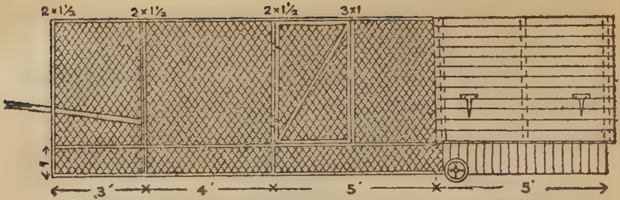


Fig. 7—DIMENSIONS FOR POULTRY HOUSE

now fitted and hung a flapdoor of matching on battens running the length of the house. The roof matching should overlap 1½ in. each end.

The nest-box consists of a trough 4 ft. long with sides 4 in. high, divided by partitions 6 in. high. This is made separately and dropped in.

At the far end of the run, nail a cross-piece at 2 ft. 6 in. from the ground, and between the next rafter—3 ft. from that end—another cross-piece 2 ft. from the ground. Insert two lengths of 2 in. by 2 in., 2 ft. apart, for the handles—4 ft. long—which will be used for moving the fold; these go under the end cross-piece and above the next. Board up the end of the fold between the upper rail and the cross-piece above it, cutting away holes where the handles protrude. The space at the end between the upper and lower rails is occupied by a galvanized feeding trough (Fig. 6), which hinges back for filling and cleaning. Similarly a water trough is provided at one side. Board over on top of the handles inside to make a sloping platform; this acts as a shelter in heat or in bad weather.

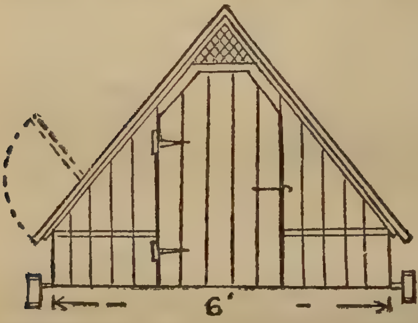


Fig. 8—POSITIONING OF THE RAFTERS

Half-way along the run, at a convenient rafter, hang a

light door, made of 2-in. by 1-in. stuff and wire netted, for entrance to the run. This closes down by its own weight and need not be secured. It hinges to the rafter and closes against a piece of 3-in. by 1-in. board nailed to ridge and upper rail.

The run is now covered with 1-in. wire netting. The woodwork is to be tarred and creosoted all over. Two wheels 12 in. in diameter and 2 in. wide are attached to the end of the fold nearest the run (Fig. 7). A piece of tarred felt or zinc may be tacked on over the ridge of the house as a capping to keep out damp.

The principal dimensions are indicated on Figs. 7 and 8, which also show method of framing the structure. The reader is referred to other relevant articles for information on joints and the making of simple doors.

RABBIT HUTCH.—The following is a description of a hygienic and simply-made rabbit hutch. It can, if desired, be made with a solid wood floor; but a wire floor, having a droppings tray beneath, will be found more sanitary and easier to keep odourless. The hutch has been designed with a false roof which is easily removable; it being a common experience of rabbit owners that they soon require increased accommodation for their stock, and cages of the sort here described can then be built up in tiers. If the rabbits are kept in a shed or outhouse, no weatherproof top is required, of course.

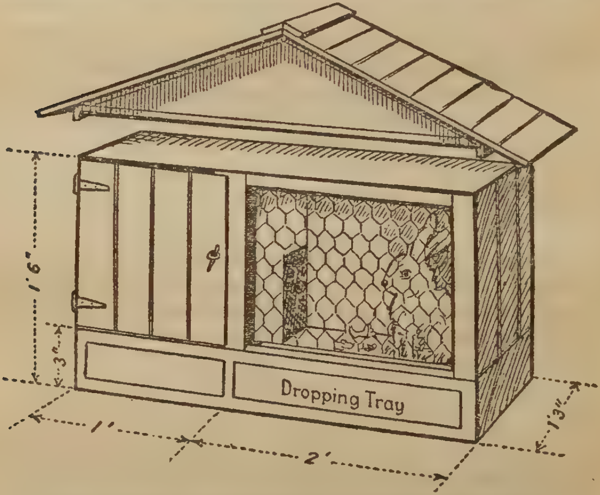
The dimensions of the hutch are 1 ft. 6 in. high from the ground, 3 ft. wide, and 15 in. deep. The false top is extra, of course.

The framework of the hutch consists of four uprights, 1½ in. square, into which top and bottom rails of the same section are halved or mortised. The lower rail should be 3 in. clear of the ground and the upper rail flush with the top.

At 1 ft. from the left-hand post, halve-in uprights 2 in. by 1 in., running from ground level to top rails and flush with the front and back of the frame. These serve as supports for the wall of the sleeping compartment. Inside these posts and inside the right-hand posts screw on pieces of 1 in. by 1 in. to act as runners for the droppings tray. Between the centre uprights a piece of 1½ in. by 1½ in. is to be halved-in to form the support of the floor. Now secure the close-mesh wire floor between

the right-hand and centre rails, stapling it securely and stretching it as taut as possible. Half-inch wire netting is suitable. The corners will need careful manipulation to get them to lie neatly round the posts; the last two should be cut only when the three sides are secured.

The left-hand side is now to be floored with match-boarding up to the right-hand edge of the centre cross-rail; wire is not cosy enough for mother and young.



Roof extends 6 in. in front, 1 in. at back, 3 in. at sides

Stout three-ply board is to be nailed on the right of the centre uprights, a piece 8 in. square having been cut from the rear bottom corner to form a door to the sleeping compartment. The partition extends to within 2 in. of the roof, thus allowing ventilation without draught.

The sides and back of the hutch are matchboarded from the ground to flush with the top; a 1-in. square strip is run across the top rail at the front and along the bottom rail to carry the wire front. Beneath this, on the left-hand side a piece of board is to be nailed across the left and centre posts under the door.

A light matchboard door is nailed on to battens, hinged to the left-hand side, and secured to the middle post by a button or latch.

There remain now the cage front and droppings tray to be made. The cage front consists of a 1-in. by 1-in. frame with halved joints at the corners. Half-inch mesh wire netting is tacked on to this; or if a neater fitting is desired, then galvanized wire or cycle spokes are pushed through from top to bottom edges, at intervals of 1 in. The holes in the lower frame should be slightly smaller than the gauge of wire or spokes, so that when the wire is driven in it has a good hold. The front is hinged on to the 1-in. piece at the bottom and secured at the top by two turn-buttons.

The dropping-board or tray is made of a piece of zinc turned up ½ in. at sides and back and 1½ in. on the fourth (front) edge. It should slide freely on the guides. The wide edge is screwed on to a board about 3 in. wide, which fills the space between ground and the bottom of the rail carrying the cage front, thus giving a neat appearance to the cage. A fixed handle to this drawer is a convenience.

The false top (if required) for an outdoor house is made of two triangular frames, 3 ft. 4 in. wide and 1 ft. 6 in. high—that is, 2 in. wider than the outside of the house when matchboarded. Underneath the ends of these frames are screwed two 1-in. square transverse pieces which will fit exactly over the ends of the house. They can be screwed into the sides to hold the roof in place. Matchboarding should extend 4 in. beyond the front, 2 in. at sides, and 1 in. at back.

The whole cage should be coated with creosote and tar, and the roof felted.

If the cage is to stand in the open, some form of support must be arranged 2 or 3 ft. from the ground, to keep the cage clear of predatory animals. This can most easily be managed by bolting legs of 2 in. by 2 in. to the sides of the hutch; or, better still, by a couple of brackets let into a convenient wall or fence. Some arrangement must be made for holding down the hutch to the brackets.

SHED, IN SECTIONS.—A very convenient size for a span-roof portable shed is 8 ft. by 7 ft., since the roofing sheets of asbestos-cement can be obtained just the size to fit each half of the timbered roof. Asbestos sheet may

be used to line the sides also, or feather-edge boards could be used instead. The height must be arranged to requirements at the eaves (where the roof adjoins the walls). A height of 6 ft. here is assumed in this article. We shall thus need for framing eight lengths of 2-in. by 2-in. wood as posts, 6 ft. long; four 7-ft. lengths and four 8-ft. lengths as horizontals; and four 5-ft. lengths for struts.

Frames.—Three 6-ft. posts are laid down and two 8-ft. lengths—one at the bottom ends and one 4-ft. higher. The joints are to be mortised and tenoned to the outside posts and half-lapped at the intersections. The total length of this frame should not be more than 7 ft. 8 in., for the roofing must overlap a little. Make the halved joints permanent with paint and screws and repeat this for the opposite side. To the projecting tops, or horns, must be securely screwed a piece of 3 in. by 1 in. as a barge board, exactly the same length as the framing and flush with the top. Another frame is to be made up in a similar manner. The two side frames when finished should be covered in whatever material is used, spaces being left in the frame for a window, if one is to be provided in either long side. The covering is placed up to the underside of the barge boarding, flush with the lower horizontal, or floor-plate.

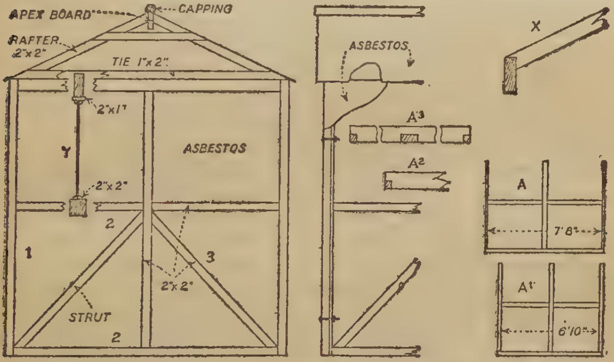
Next lay down a 6-ft. post and mortise and tenon to its lower end a floor-plate, cut to 6 ft. 7 in. long. A similar horizontal is to be fixed at the top. The post is to be central in the length of the floor-plate and the header. Two 6-ft. lengths of 2 in. by 1 in. are then jointed vertically to the ends of the floor-plate and top rail to form the outside members of the frame, being let in flush with the face of the 2-in. by 2-in. floor-plate and the header. A similar framing is made for the other end except that 2 in. by 2 in. is used for the vertical member at one side instead of 2 in. by 1 in., to act as a door-post.

The four sections must then be stood up with the two ends inside the sides, and fixings arranged at each corner. The uprights are bored through and bolted together with coach-bolts. Use a washer inside, under the nut.

This gives what may be termed a box without a lid or door. Six lengths of 2 in. by 2 in., 8 ft. long, will make

the rafters, which support a piece of 4 in. by 1 in. (the apex board). They must be cut at the correct angle of slope, which is determined by the roof angle. If two lengths be stood at experimental angles until each measures 4 ft. from eaves to apex the angle can soon be estimated. A bevel should be set at this angle, which is the same at the eaves and apex. At the eaves the rafters are cut in a "bird's-mouth," and all should be cut to exactly the same dimensions.

With two rafters fixed temporarily at each end of the building, resting on the sides, the apex board can be



WORKING DRAWINGS FOR BUILDING A SHED IN SECTIONS

lifted into place. If just pinned together it will remain firm enough while the permanent fixing is done. Two ties of 2 in. by 1 in. should be screwed to each pair of rafters, one at the top just below the apex board and one just above the top of the walls. A longitudinal tie should also be screwed—on each side—to the inner face of rafters about 6 in. above point where the rafters rest on the walls.

The roof sheeting can then be fixed on. If asbestos sheets are used, a sharp drill must be employed to make holes the size of the screw stems; round-headed screws are best for the purpose. Before tightening them, a little putty and paint should be placed under the heads. Keep the sheeting well up to the apex board. Beware

of splitting the asbestos by driving the screws too tightly. A piece of 2-in. or 3-in. capping, securely screwed to the top of the apex board, will complete the roof.

When fixing the cross-ties to the rafters, pull the rafters in a central direction to give a little play at the eaves on the bird's-mouth joints. A window is fixed between the 2-in. by 2-in. framing by means of $\frac{3}{4}$-in. half-round bead. The outside beads are tacked in first, the glass then puttied in from the inside, and the inside beads pinned in tightly to the glass. A light ledged and braced door, similar to that shown in the article on DOORS, is suitable. The roof may be fixed at any convenient points to prevent it being disturbed by winds. By removing it and then taking out the bolts at the sides, the whole building can be dismantled into five sections. The roof is easily carried by two men and is the heaviest section of all. The cross-ties and the longitudinal ones will hold it firmly together.

In cutting asbestos sheeting a sharp steel point is used to groove each side; if the mark is laid on a piece of batten and the sheet pressed down at each end it will break quite cleanly. The deeper the grooving the better the chance of a clean cut. The open ends of the roof can be covered with asbestos, and ventilation can be arranged here. If the fixing of the end sheeting be left until the roof is assembled, the whole end can be covered right to the apex of the roof. Any joints in the sheeting may be made waterproof with cement.

All woodwork resting on the ground should be creosoted. The building can stand on a flooring or on a concrete base. When dismantling or moving the shed, take care not to break the covering—which is very brittle although splendid material for its weathering properties. Small-section guttering is fixed at the eaves, and the down-pipe can be led to a hole dug in the ground and filled with large cinders to form a soak-away. Alternatively a butt or cask can be used to catch the rain-water.

If a wooden floor is decided on, lay down two 8 ft. 6 in. lengths of 3 in. by 2 in. as sleepers; across them go the joists proper, 3 in. by 2 in. spaced at about 15 in. centres. The joists are to be spiked at each end to the sleepers. On top, lengthwise, running in the same

direction as the sleepers, are laid the floorboards. Plain-edge floorboard, 1 in. thick, is the best to use for the decking.

Though we have not stressed the matter here, absolute squareness is essential in all the framing joints and in all parts of the building that meet at right-angles. Reference should be made to other constructional articles, and also to those on the various joints.

SHELVING, HOW TO ERECT.—Some aspects of this work are dealt with in the articles on BRACKETS and BOOKCASES elsewhere in this volume. Here we shall describe the fitting of shelves to a wall, the fitment being merely of a utilitarian nature. The wall in question is twelve feet long, and the shelves run entirely across it to the return walls at either side. In this job strength was the first desideratum, and the job was required to be carried out neatly, but not to bear any ornament. We shall specify the component dimensions, and they will serve as a guide in any similar work.

It is important in work of this nature to proportion the thickness of the board to the span it will take between brackets or bearers. In the job under consideration, 1-in. board was used, and it was 10 in. wide. There was a plain 6-in. skirting around the room, and the uprights or end pieces that supported the shelves began from the top edge of the skirting. These uprights were 7 ft. long, of the same stuff as the shelves. They were screwed to plugs in the wall. Midway in the length of the wall a batten was attached vertically to the wall, running from the skirting to a point 7 ft. above it and level with the top edges of the uprights.

The batten was a piece of $\frac{3}{4}$-in. by 2-in. deal. For the bearers or ledges $1\frac{1}{2}$-in. by $\frac{3}{4}$-in. was used. The outer ends of ledges were cut back at an angle, and the arris chamfered off to make a neat job. The arrises of the vertical batten also were bevelled off. In marking off the sides and the vertical support for the bearers and the centre brackets, one side—the left-hand—was taken as the starting point throughout. The first shelf was at 2 ft. from the floor. Its line was squared across the upright an inch below to show where the top edge of the bearer should come. This bearer was screwed on. Measuring from the floor, a mark at 1 ft. 11 in. was made,

to show the approximate position of centre bracket, and another for the right-hand ledge.

The floor line, especially in a house some years old, may not be level, so that direct measurement does not always answer in fixing the height of shelves. A test may be made by temporarily screwing up the right-hand ledge and taking the level on a long batten resting edgewise on the top edges of the ledges. The batten itself, in a long span, may sag, so that the bracket for the centre support should be screwed up to its batten and the level taken to this point first. When the bracket is attached firmly at its proper height, the level is obtained from it to the right-hand ledge and the latter screwed home. Having thus accurately levelled the first shelf, we can mark out the position for the remaining ledges and brackets by direct measurement from the shelf already fixed.

The brackets were 11 in. by 10 in., the long arm of each being screwed to the vertical batten. Screws from the bracket to the under side of the shelves held the latter firm at the centre, and oval wire nails were driven skew-wise at the end into the side supports. The shelves above the first were a foot apart, the top one resting upon and nailed into the top edge of the uprights and having also a centre bracket beneath it.

Short but stout screws are needed for fixing brackets, since the batten in such a case is thin, and the shelf itself is only a bare inch thick. In boring for them, go only the bare distance into the wood that corresponds to two-thirds of the length of the shank, and avoid making the holes too big.

When fixing brackets, take care that they are set up perfectly vertical, with the bearing surface at the proper height. It is essential that the shelving boards be a nice tight fit against the sides, and the happy mean must be attained—avoiding on the one hand, a board so long that it needs to be jammed or, on the other, one that is loose. Screw up the centre bracket before the shelf is tried in place, since this will prevent any sagging and enable the length to be judged accurately.

It does not follow that the correct length for one shelf will be right for others; the walls may not be truly vertical. It is not easy to remove a very small portion of the board

by sawing, and a sharp smoothing plane may have to be used on the edge of the shelf to get it to fit. As a guide to the length of the shelves, two overlapping lengths of 1¼-in. by ¾-in. batten or of similar stuff can be used as measuring rods. They are slid along until the outer ends touch the uprights—the rods held tightly together, or the overlap marked, and this dimension transferred to the board to be sawn.

SWING, HOW TO CONSTRUCT.—The first point to consider in planning a swing is the height of the cross member—or header—at the top. If the children are young, a cross-bar about 8 ft. above the ground will answer. In case it is thought convenient to have the height adjustable, on account of minimizing danger to small children, a good method is shown at Fig. 1. A chain is securely fixed at its ends to two hooked bolts complete with washers and flynuts. The bolts must be long enough to project through the posts the 2-in. way and leave the hook clear; they enable the chain, which must not be longer than 3 ft., to be strained between the posts when the flynuts are screwed up.

At the points where the chain and suspending cord intersect, a spring hook or loop must be attached to form as tight a joint as possible. A series of holes drilled through the posts will permit a number of adjustments.

Having decided on the height desired for suspension, we must allow for about 2 ft. to 3 ft. to enter the ground on each post. The following timber will be needed, assuming that a height of 8 ft. above ground is settled on: two lengths of 10 ft. or 11 ft. for posts; one of 4 ft. for the header; two of 3 ft. for pegs to take the struts; four of 4 ft. to make the struts.

These timbers can be 4 in. by 2 in. or 3 in. by 2 in. in section, as preferred. The holes for the posts are to be at least 2 ft. deep, and 3 ft. is better. The posts stand up 8 ft. above ground, so that their length must be arranged to suit the depth that is decided on. The character of the soil is to be considered in this connection. Though a wide hole is not needed for the posts, it has to be spacious enough to allow free use of the spade in removing the earth.

Some people use a shallower hole (say 2 ft. deep) and connect it with the one for the other post by a trench

at right-angles. The latter is just deep enough to take a brace rail of 3 in. by 2 in. that is bolted across the two posts at a point about 1 ft. from their lower ends. In addition to spacing and stiffening the posts, this cross-rail takes and equalizes the lateral thrust on the posts when the swing is used.

The posts are erected temporarily and chocked with brick, old concrete lumps, etc., while a test is made for "plumb" and squareness. This process is described in other articles. Ram down the hard core and pour in a mortar of sand and cement to bind it. No earthy matter must be among the hard core. Fill in the hole with concrete to within a few inches of the ground, and the cross-trench also if one is used, stay and guy the posts and leave until all is firm. The joints for the header can be cut before erecting posts, and the header temporarily attached. This makes it essential that post holes are exactly the same depth, and that no loose earth, etc., be allowed to get under butts of posts and alter the level once it has been made right and tested by a spirit level on top of the header.

The brace rail, if put on nice and square, can be used as a rough guide and levelled across first. If a brace rail is not used, and the header joints are cut *after* posts have been fixed, the posts must be braced temporarily by stout battens nailed on diagonally to their 2-in. faces, one on either side, crossing in the centre.

The header or cross member, if fixed later, can be dealt with as follows. First cut the posts dead level. If the ground is uneven, a batten and spirit-level should be used (Fig. 2). They are to be made level with each other at the top and a halved joint cut between each post and the adjacent end of the cross-bar. Fig. 1 shows the posts and rails of 3 in. by 2 in. as timber of this size will be strong enough to carry persons up to about 10 stone in weight. Posts of 4-in. by 2-in. section would make a more durable job, a point worth considering. The joints are first to be painted, and then fixed together with a $3\frac{1}{2}$-in. or 4-in. coach-bolt, $\frac{3}{8}$ in. or $\frac{1}{2}$ in. thick. A large washer must be placed under the nut or the nut will become buried in the timber and the joint will work loose very quickly.

The pegs are to be pointed with the axe so that all

points are central, as in D1. They are driven in as shown, at an angle of approximately 70°, and left to project about 6 in. above the ground-level. The distance from the posts would have to be increased if the posts were taken to a greater height, which also means increasing the length of the struts. For an 8-ft. swing the distance for pegs is about 2 ft. from the post. Take care in placing

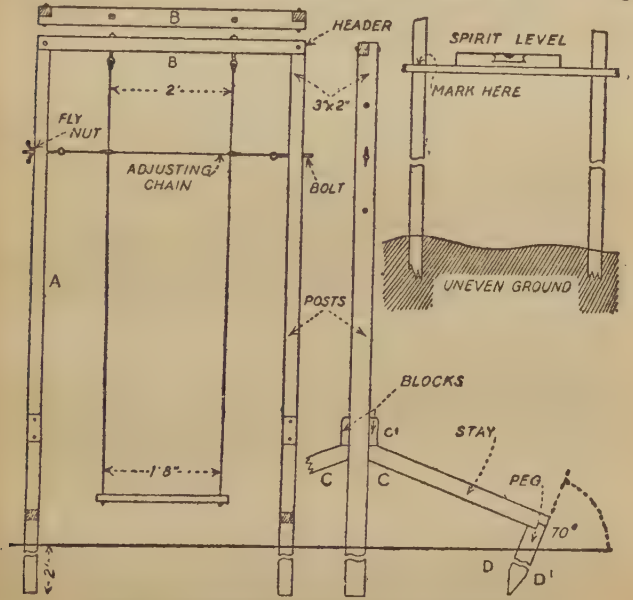


Fig. 1—DIMENSIONS FOR CHILD'S SWING

the pegs to make the distance and therefore the length of the struts uniform, or an ugly appearance will result.

Take one strut piece and fit to the peg and post as shown at C and D. The block shown at C1 is one of four short pieces of 2-in. by 1-in. batten well screwed on to the posts; if forced down tightly and level on to the top ends of the struts, a nail is all that is necessary to hold the strut in place on the posts. The joint between C and D may be halved at the sides or half-butted on top.

The side joint is more convenient for bolting, but more likely to provide an inlet for water. All joints should be well painted before fixing.

Seat and Suspension.—A piece of 11-in. by $1\frac{1}{4}$-in. deal board 2 ft. long is needed for the seat. Bore four holes in the seat to take the cords or chains or bolts and nuts. They must come not less than 2 in. from the edges of the seat. The holes in the header should be about 4 in. wider apart than those in the seat, to obviate side swaying. Hook bolts are used for the suspension, and spring loops are safest as a means of attaching the cords or chains. Four-point suspension is used on the seat, the four short cords or chains rising about 18 in. above to the single chain. A piece of good stout waterproof canvas tacked to the seat—put the tacks underneath—will improve the job and prevent the users slipping off.

The more care given to good jointing the better will be the rigidity and stability of the whole job. Make sure that all timber buried below ground level is well creosoted, for if rotting takes place a sudden collapse may occur with, perhaps, serious results. The whole fabric above ground should be well painted as a preservative, and all joints well filled with putty; bolts, etc., must be greased occasionally, and if rope be used for suspension, it must be overhauled periodically. The best sash cord (No. 8) is very suitable for the suspension, though light steel chain is more permanent.

Where the hand-holds come, some form of "grip" should be bound on to the cords or chains, to save the hands becoming blistered and sore. A piece of old carpet or felt will do for this purpose.

If spring-hooks be used, the cords or chains and seat can be taken indoors in wet weather. It is as well to take them down at night, since the damp air will work havoc with the metal parts and make the seat damp and clammy. At the approach of autumn the seat and chain are taken down and packed away till spring, and all metal parts need first to be well smeared with petroleum jelly.

In order to protect the header of the swing, a roof or pent-house of zinc can be rigged up over the header to shoot off the rain.

TOOL CHEST.—The making of a proper receptacle for his tools ought to be one of the first jobs of the amateur woodworker. He must budget for future needs as well as present ones, so that the box should be large enough to take the tools he will have when his kit is complete. Of course, a kit never is really complete, for the buying of tools is a habit that grows upon one, and there is always some item that can be got to facilitate the work; or enable more of it to be done by the worker himself; or permit jobs to be tackled in the proper style. The facilities afforded by the modern timber-yard and its saw mill enable many tools to be done without, and the worker no longer needs the multifarious collection that was kept by the joiner of fifty years ago.

A good size for the tool chest would be about 2 ft. 6 in. by 1 ft. 4 in. by 1 ft. 4 in. inside. This would allow a 24 in. or 26 in. saw to be accommodated in the lid. The thing to do is to make the box to suit the tools in hand or in prospect, and so its dimensions will naturally be governed by this consideration. Beware of making too big a box, however. It is far better to use two smaller boxes rather than a single heavy and unwieldy one; tools are heavy, and whenever the chests have to be handled by removal men they are the cause of grumbles. Portability, therefore, is to be considered in the design.

Sound T. & G. floorboard, 1 in. thick, is the best material for the box, and it should be strengthened by iron angle-plates fixed at the corners outside after the job has been painted. The two ends are made up on 2-in. by 1-in. battens, fixed so as to come flush with the vertical edges and permit the front and back to be screwed to the edge of battens. The bottom is nailed to the edges of the sides, and is further strengthened by four ⅝-in. by 2-in. battens fixed on underneath. These battens take the wear, and each is further secured to the sides by iron angle-plates screwed on.

Lifting handles of iron can be used, but we prefer hand-holds made of a loop of stout hemp rope passed through grooves in the inner face of a stout wooden block screwed on to each end outside the box. The grooves can be started with a gouge and deepened with a red-hot iron; they must be just deep enough to allow the rope to be inserted, but not to allow the knot at its

lower end to pass. The lid of the box fits on over the body; it is made up like a shallow box with a front and two ends but no back. Its three sides are made of 2½-in. by ¾-in. deal screwed to the edge of the lid. At the corners these can be mitred, rebated, or merely butted. Stout butt hinges of the type used for doors are the best for the purpose, but back flaps will do if stout and wide enough. Three battens of 3-in. by ¾-in. stuff are to be attached outside the lid; they can be chamfered on all four edges to take away any appearance of heaviness. The inside of the lid is to be left clear to take the cleats for saws and other tools there to be located.

A stout hasp and staple, secured by a padlock, may be fixed to the lid and front. An alternative is a box-lock, like that provided on trunks, with a hinged staple fastened to the lid. The hasp or staple must be screwed to the inside of the front of the lid, unless the staple or lock is fixed to or let into a ¾-in. block screwed on to the body of the box, to bring it level with the face of the front side of the lid. A hinged stay should be bought or made and attached inside to box and lid. It holds open the lid and prevents it from falling right back. A simple stay can be formed out of ⅝-in. by ⅛-in. flat mild steel; two pieces are riveted together at one end with a washer between them, to form a knee-joint, and are screwed at the other ends to lid and body of box respectively.

The interior of the chest at the bottom is to be partitioned off to take the jack plane and smoothing planes, each in its own compartment, and any other tools that need to be protected in this way. Make up the rest of partitions as a separate unit and insert it complete into the tool chest. Shallow trays for other tools and implements are made of ¾-in. stuff and sound ¼-in. plywood. The bottoms should be screwed on. Paint the tool chest two flat coats and use rustless screws for the angle-plates. If soldering implements are kept in the chest, do not include the sal-ammoniac cleaning block or the acid flux.

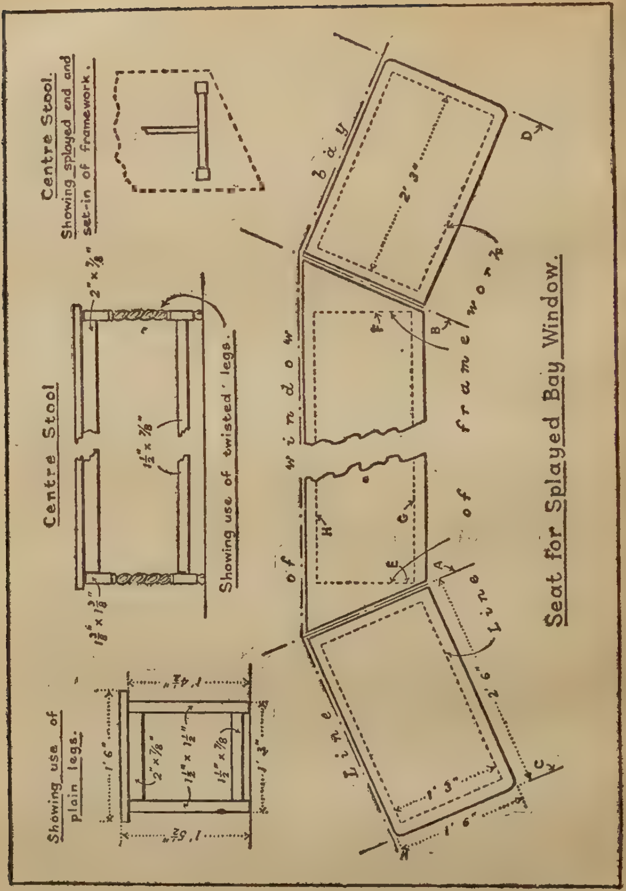
A place for the oil-can must be contrived and another for a metal receptacle for methylated spirits, if a small blow-lamp is included. If a benzine or petrol lamp is kept, it should be emptied of spirit before putting in the

box, and on no account should petrol or benzine be stored in the tool chest. Except when a lamp is to be packed away for some time, it is better to find a place for it on a shelf in the workshop. As a final injunction we would advise that "junk" of any description be barred from the box, and that all loose material, nails, screws, etc., be kept in metal boxes having lids.

The metal-working tools are best located in a box by themselves. They are heavier than the carpenter's tools and the weight is concentrated in a smaller bulk. A smaller box on the lines of that described above can be made especially for them.

WINDOW SEAT.—Two methods may be used to make the fitment that is described below: the legs may be cut from ordinary 1½-in. square deal, with rails and seat of the same wood, or it can be made up from turned or twisted oak or birch legs and the rails and seat formed of oak. Another alternative is to use oak for the rails and seat and to cut plain legs from deal. The piece of furniture illustrated in the diagrams was made up for a splayed bay-window with a rather long centre section—5 ft. 4 in.—and splayed portions each 2 ft. 6 in. long. The height to the under side of window nosing was a trifle less than 2 ft. 3 in., and the top surface of the seat was 1 ft. 5½ in. high from the floor; 18 in. is a suitable width for the seat. Since there will be a skirting board to accommodate, the frame work must be set in enough to clear the skirting, and in the job described the seat projected 1½ in. at front and back and at the splayed ends.

The angle of splay will vary in different windows, of course, but the method of laying out will be the same and only the difference of angle will call for modification in the working drawing. When commencing the work, clear the bay of furniture and roll back the carpets; a chalked string, try-square and straight-edge will be needed. Lay the square flat on the floor close against the skirting at the junction of the mitre, the wooden part against the skirting and the blade pointing outwards in line with the joint in the skirting or that in the window-board above. Mark a pencil line on the boards along the blade of the square. Do the same at the other side of the bay where the splay joins the square portion. These lines are to be extended by means of



the straight-edge to 18 in.—measured from the face of the wall itself—long, marking the projection of the seat. Take the length of the splay on the window board above, and decide the length of the seat at this portion, measuring from the edge of the mitre in the window board.

The nosing of this board projects slightly, so that our measurement must be made at a point a little back from the edge, flush with the face of the wall.

Assuming the length chosen is 2 ft. 6 in., this is laid off on the floor against the skirting board, and a line squared off across the floor at this point, at right angles to the face of the skirting. Measure and mark the splay at the other side of the bay, and extend both lines to 1 ft. 6 in. from the face of the wall. These points and those of the mitres may be marked for the time being by a tack driven into the floor at each. Chalk the string and "snap" a line on the floor to join the 1 ft. 6 in. mark on each of the lines we have squared outward from the bay across the boards. We shall now have on the floor a series of lines like those shown in the diagram. In this, solid lines represent the outline of the seat board, and the broken lines, A, B, C, D, indicate those produced on the floor. The chalked line on the floor marks the projection of the front edge of the seat board.

The next thing to do is to indicate on the floor the position of the framework of the three stools that compose the fitment. Deal first with the centre stool. At the front edge the leg is to come about 1 in. from the end of the seat—in this case cut back to a bevel depending on the angle of the splay. At the point in question square off a line back to the skirting and at right angles to it. At the back it will stand in some inches from the end of the stool, where the mitred edge overhangs the framework. Serve the other end similarly (lines E and F in diagram), and snap chalk lines across to connect them, at points 1½ in. and 1 ft. 4½ in. respectively from the front edge of seat (G and H in diagram). These four lines mark the outside of the framework of centre stool.

Mark out now the framework of the left-hand stool. Lines are squared out from the skirting at points 1½ in. from each end—that is, inwards from lines C and A—and the front and back are indicated by chalk lines as with the centre stool. The right-hand splay is to be marked off similarly. Measurements taken directly from our chalk and pencil diagrams on the floor will give the outside dimensions of the three stools. Of course, we could have made scale drawings on paper instead of full-size ones on the floor, but the latter is,

for the novice at any rate, a simpler method of determining and indicating angles and measurements. A bevel square set to the angle of the splay is helpful in transferring the bevel to the woodwork, and in testing it as the job proceeds.

Preparing the Legs.—Choose sound prepared 1½-in. by 1½-in. deal and cut off twelve legs a little longer than the finished dimension (16½ in.). Mark out the mortises on all and see that they coincide all through the set. The top rails are cut from 2-in. by ⅞-in., and the lower rails from 1½-in. by ⅞-in. stuff. The top or bearer rail is flush with the top of the legs. The lower rail can be 1 in. from the floor line at its lower edge. A single long lower rail connects the lower rail of the ends, but a rail could be tenoned in at both front and back if desired. In the case of a long centre section an extra pair of legs could be fixed midway in its length. These legs would be slotted at the top to come up on either side of the top rail, which is continuous. At the back of the rail, where the top of the leg intersects it, a groove is to be formed the width of the leg and ¼ in. deep, so that the slot in the leg is less than the thickness of the rail by a quarter of an inch. This arrangement—a bridle joint—is to hold the leg in its place laterally.

When the joints are cut, assemble the ends of the stools, glue them and cramp them. The long rails can now be prepared, taking measurements from the diagram on the floor. The two end stools are alike in every respect, and should present little difficulty. The frames may be completed when the ends are fit to handle. The centre one is to be jointed and put together temporarily, but not fixed. Cut the oak or deal boards for the seats and joint them. The number of boards will depend on the width in which good sound timber can be obtained. Wide boards are more liable to warp, so that the worker must use his judgment and make the best choice he can, according to the circumstances. The seat is not to be fixed or trimmed down to its finished size until later; it should be at least 2 in. longer. When the two end stools are finished, except for fixing the seats, they may be stood in place on the floor and thus tested. Lay the seats in position, projecting inwards 1½ in. from the legs. The location of the legs of the centre stool can now be verified

by standing in its place the frame, if it has been assembled—or the two ends if it has not. If everything seems correct the centre stool can now be glued up and put aside until the glue is hard.

Cut the splays on the ends of the seat for centre stool, taking care not to remove too much wood. One end is first to be cut and tried against the adjoining stool, the seat of the latter being in its proper position. Saw the other end and test similarly, making any small adjustment that may be needed. Although the side stools can be moved to or from the centre one, the splay of the window would prevent them going more than a fraction of an inch beyond the proper line. If the centre seat should be cut too short, an ugly gap would therefore be left between its ends and those of the side stools. The seats are to be fixed by screws inserted in holes bored on the skew through the rails from inside. The proper way to do this is to form a gouged pocket for each screw. The edges of seats—except where they meet at the ends of the centre ones—need to be rounded off, and the outside corners of the two end stools may be slightly rounded also.

When all these stools have thus been completed, except for staining or polishing, they are to be finally tried in place and the inside edges shot with a plane, if necessary, to bring the joints close. It should not be necessary to fix the stools to the floor or to each other; it is better to leave them portable, but a couple of iron plates might, if desired, be screwed beneath the joint at each side of the centre stool to hold it to the others.

If turned or twisted legs are being used, the job should be carried out in oak throughout. The three sets of legs can be bought for round about ten or eleven shillings the lot, and although this makes the job more costly it is worth it for the enhanced appearance of the article. Choose legs having a squared portion near the lower end to take the mortise for a rail.

Fitted box-cushions would complete our seat and make not only an elegant but a comfortable piece of furniture. Ordinary cushions are to be preferred, however, where there are young children, who, by the way, will be not the last to appreciate and use the seat. If the cushions were taken off, little harm would result; a wax polish or oiled finish might be used where hard wear was anticipated.

WOOD-TURNING.—It is rather surprising that so few amateur woodworkers consider purchasing a lathe. The reason is, probably, because many furniture parts, such as ball feet, balusters and table legs, can be bought so cheaply nowadays that the woodworker regards buying a lathe as an unjustifiable expense. Such lathes are, however, so cheap that the sum expended on one can be recovered in the space of a few weeks. Moreover, they are not difficult to operate once the knack has been learned, and besides being able to use one's own designs in fashioning furniture details, there is always the satisfaction of knowing that every piece has been made by the home worker himself.

Now, although many of the wood-turner's jobs may be produced on a metal-turner's lathe, it is proposed here to deal solely with work that is turned out on a lathe designed for wood-turning (Fig. 1). The lathe itself is much the same as that used for metal-turning, but the bed, instead of being made of a flat piece of cast iron with a slot down the middle, consists often of a tubular piece of steel with a keyway cut down its entire length. One end of the tube fits into a hole in the headstock and is fixed there with a set-screw. The other end of the tube fits into a bracket at the tailstock end.

Both the headstock and the end bracket are fitted with feet for screwing firmly to a bench. The tailstock fits on to the tubular bed and may be fixed in any position by means of a set-screw. Instead of a slide-rest, such as is used for metal turning, a tool-rest is provided. The worker will gather from the last-mentioned detail that this article deals with hand turning. A slide-rest can be used in wood-turning, just as in metal-turning, but most amateurs who work in wood prefer the use of hand tools rather than slide-rest tools. Readers, however, who already possess a metal-turning lathe may easily adapt it for wood-turning by using a little ingenuity.

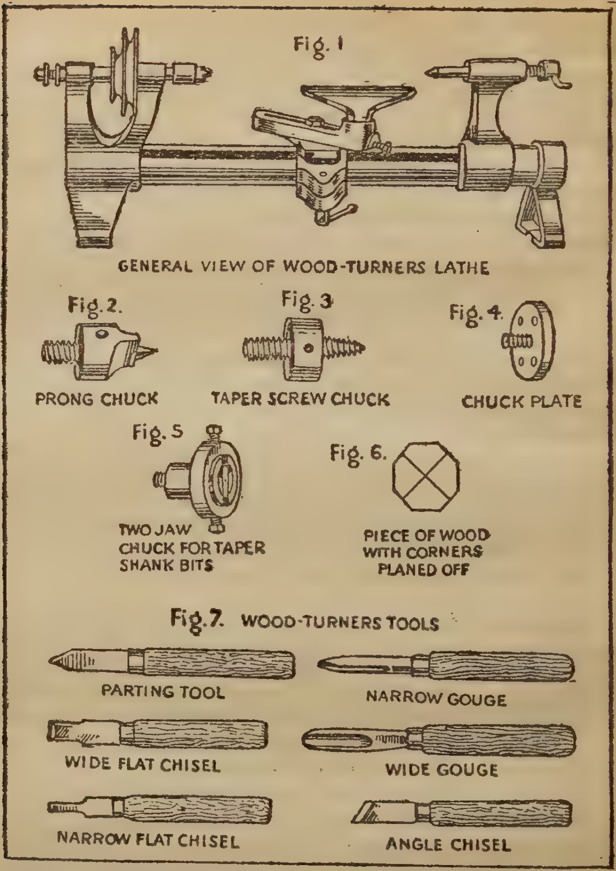
The manner of operating the wood-turner's lathe is similar to that used in metal-turning, but a high speed of running is essential if good work is to be turned out. The driving belt, therefore, should be on the smaller diameter of the pulley on the mandrel, and on the larger diameter of the fly-wheel pulley.

Accessories.—The most important accessories for the wood-turner are chucks for holding the work. A self-centring chuck, although expensive, is well worth the money expended, but is not absolutely essential. A prong chuck, however, *is* essential and is illustrated in Fig. 2. The worker will note that it is made with a screw end, because the mandrel of the lathe we are describing has a female screw in its nose. The use of the prong chuck will be apparent later. Another essential is the taper-screw chuck shown in Fig. 3. This consists merely of a screw at one end which fits into the mandrel nose, a flange, and a taper screw on which a block of wood may be screwed for turning. Another useful accessory is a chuck-plate, as shown in Fig. 4. A two-jaw chuck, shown in Fig. 5, is intended for holding taper-shank bits; it can be bought very cheaply, and although not quite so useful as a self-centring chuck, can take the place of the latter if expense is a prime factor.

Wood-turning tools are similar in design to carpenters' tools, but they are generally longer and more robust in build. A set of six tools is illustrated in Fig. 7, and these will perform most of the work the amateur wood turner will wish to attempt. Of these six tools the angle chisel and the gouges are the most important, but we will return to the subject of tools later.

Simple Turning Operations.—First let us obtain a general idea of what we are going to do and then work from the general to the particular, dealing with each point as it crops up. We begin with a length of wood which is square in section. The first thing to be done is to mark off at each end the centre point. It is not necessary to use callipers to do this since, by drawing lines from opposite corners, the point where they bisect each other will indicate the centre.

The first problem of a wood-turner is to avoid anything that will tend to make his tools dig into the work. Obviously, therefore, acute and right-angle corners must be avoided as much as possible. The corners of our length of wood should now be planed off, leaving the wood octagonal in section as it appears in Fig. 6. The ends should, of course, have been sawn off square. Across one end, along the line of one of the pencil marks, make a saw-cut to about a depth of $\frac{1}{8}$ in. At the other



LATHE, ACCESSORIES AND TOOLS FOR THE WOOD-TURNER

end, by means of a centre punch, make a small centre hole.

Now screw the prong chuck (Fig. 2) into the mandrel and place the end of the wood having the saw-cut in it against the prong chuck in such a way that the centre,

point of the chuck enters the saw-cut at the point where is the end centre. With a mallet knock the piece of wood on to the prong of the chuck, making sure that the prong enters the wood along the line of the saw-cut. The prong will now be embedded in the wood and will drive the wood in the lathe without slipping. Bring up the tailstock so that its centre enters the pip made for it in the piece of wood. Screw up the centre tight to begin with, in order to give the work a good bearing to run on. A small piece of fat or of soap should be placed in the centre pip as a lubricant.

Look at the illustration of the lathe (Fig. 1) and note that the tool-rest is made in the form of a T with a long cross stroke. Its shank fits into a bracket which in turn slides along the tubular bed of the lathe. The shank itself can be raised or lowered, and for the purpose of turning the piece of wood with which we are dealing, it should be fixed in a position rather lower than the centre of the work. The tool-rest should then be brought towards the work so that it will just clear it when the material is revolving. It should project slightly on the tailstock side of the work. Now give all the bearings a good oiling before beginning to work on the material.

We shall need the gouge for the first operation. The handle should be held in the right hand, with the knuckles facing downwards and the hollow of the gouge upwards. Bring the left hand across the gouge and grasp it firmly, about two inches from the cutting edge. The tool is brought on to the tool-rest, pointing slightly upwards, and is advanced towards the job, now rotating in the lathe towards the worker. As the wood is cut away the tool should be moved to the left, along the length of the work, but only for an inch or two. Then the tool should be advanced and moved back again along the work, cutting as it goes. Do not try to cut across the whole length of the work, but remove an inch or so at a time until the work is reduced to the largest diameter required.

The exact height for cutting can be found only by trial, but if it is found that the work is inclined to tear away instead of peeling off smoothly, lower the handle end of the tool so that the cutting edge is higher.

When the turner has cut along the whole length of

the work he will find that the surface of the wood shows a series of ridges. To smooth it off, he should turn the gouge sideways slightly, to bring one of the cutting edges against the work. If a still smoother finish is required, the chisel must be brought into use. This is held in a similar manner to the gouge, but in cutting the wood the middle only of the cutting edge must be brought against the revolving work. Glasspaper may be used for a still finer finish; and for polishing, a handful of shavings, applied to the material as it revolves, will be effective.

Beginners will be well advised to begin their real turning by making tool handles, using a shop specimen as a model for size and shape.

Boring.—For boring holes or recesses in wood the gouge is generally used. If, for example, we wish to make an egg-cup, we first reduce the block of wood to cylindrical form on the centres, shape it roughly to the external design required, and then set the wood in a chuck. The tool-rest is to be swung round at right angles to the bed of the lathe, and brought up to about $\frac{1}{4}$ in. from the end to be hollowed out. Enter the gouge exactly into the centre of the work—the centre pip will serve as a guide for this—with the back of the gouge on the rest. The tool should be held level and at right angles to the work. If pressed firmly against the work, and kept steady, the gouge will act in the same way as a boring bit and will quickly bore a hole to the depth required. Then, by turning the gouge towards the worker and cutting with the left-hand edge, the mouth of the hole can be cut away and widened to the shape required. Always work from the left side towards the centre for this operation.

The foregoing are the main points in wood-turning, and practically every job that the amateur wishes to undertake may be dealt with by the processes described.

Legs for Stools.—Here is a comparatively simple job the reader may deal with when he has gained a little experience in the handling of his tools. Fig. 8 shows the leg of a stool, and the following describes how to tackle it in a lathe. Four legs, of course, will be required for the stool, but as the operation for each is the same only one need be discussed here.

A piece of wood 16 in. long by 1½ in. square is required; A and B, when finished, are to be 1⅜ by 1⅜ in. square, so that before placing the work in the lathe the wood must be planed to that size. In all probability the worker may be able to obtain a piece of wood the exact size, when it will not be necessary to plane it.

First mark off the centres of each end in the usual way, with a centre pip at end C and a saw-cut at end D. Place the wood in the lathe with the prong chuck embedded in end D and the centre of the tailstock in C. With a pencil and square mark off carefully along the piece of wood the dimensions given in Fig. 8, allowing half an inch of material for waste at each end. Thus if the length of wood is 16 in. the last mark will be made 5½ in. from the prong-chuck end. Two inches from the tailstock end comes the square piece marked A on sketch. The corners of the 2-in. piece should be removed. Similarly the corners of the piece lying between A and B should also be removed, but the turner must keep in mind the fact that at one point the diameter is 1⅜ in. and watch that he does not take off too much. A hand-chisel is the best tool to use for removing these corners.

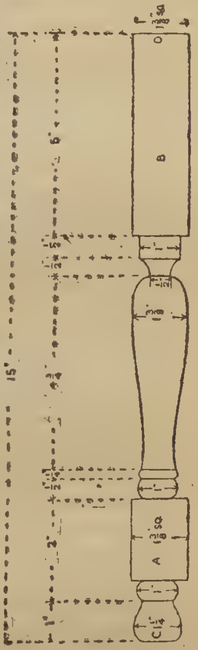


Fig. 8—LEG OF STOOL

Now set the work revolving in the lathe, and with the gouge reduce the end 2 in. of material to 1¼ in. diameter. From C mark off a distance of 1½ in. with a pencil, and with the gouge reduce the piece to the left of the mark to 1 in. Here the worker may have to make use of the side-chisel to shape the curves shown in the illustration, but most of the material can be taken away with the narrow gouge. The spare piece of material at this end can be left until the job is completed, when it is to be cut down as far as is possible without the work breaking off, and finally cut through with a fine saw.

Having completed this end, except for the waste piece, check up the length of the 2-in. piece which is to remain square in section. The next piece of material to be turned is $\frac{3}{4}$ in. in length. It is to be reduced to 1 in. diameter and shaped as shown. Note that it forms two lozenges—the one to the left of the tail-stock centre being half the length of the other. It is important that the division between them should be cleanly cut, since it adds greatly to the appearance of the finished job. A similar division should show where the thicker lozenge abuts against the square-section length, and where the thinner lozenge abuts against the $4\frac{3}{4}$-in. length with the long curve.

We must now begin on the $4\frac{3}{4}$-in. piece, first reducing it to $1\frac{3}{8}$ in. diameter. If the work has not been accurately centred it may be necessary to reduce it to slightly less than $1\frac{3}{8}$ in., but this will not matter provided each of the four legs is made the same. Working from right to left, shape as shown in the sketch, taking care not to remove too much material at the big end. The middle of the side-chisel should be used for the finishing cuts. When this part has been finished there remains an inch of the wood to be turned. Reduce this to 1 in. diameter and square off the corner under B; then shape the $\frac{1}{2}$-in. piece as shown, and finish off the curve of the body piece where it meets the latter. In order to give the whole a smooth finish, set the lathe running and rub the work with glasspaper, giving a final polish with a handful of shavings.

It should be noted that the hard woods are easier to turn than the soft woods. The most suitable are ash, beech, ebony, mahogany and oak. The soft woods, such as deal, pine, willow, and American whitewood, can be turned only with very sharp tools and by skilful work.

The novice will find useful general hints in the article on LATHES and in that on METAL-TURNING. A metal-turning lathe, of course, can be used—up to its capacity —for small wood-turning jobs.

Cements and Simple Brickwork for the Amateur

BRICKWORK FOR THE AMATEUR.—Bricklaying is, of course, a highly skilled trade, and the handyman can deal with only the simplest jobs in brickwork, but these are none the less useful in embellishing the garden or providing a foundation for a greenhouse or similar structure.

The first task in building a wall—for example, a dwarf wall dividing a terrace from a slope in the garden—is to excavate a level trench in the line of the wall, 1 ft. deep. This is râmmed hard and pegs driven in to show the height of the concrete forming the foundation. The trench should be 15 in. wide in the case with which we are dealing, and the concrete may be 4 in. thick. Full details for mixing cement and concrete are given in separate articles, but here we may say that the concrete for our job may be composed of one part Portland cement to four or five of sand and aggregate. A good proportion for the last two ingredients is three parts ballast (stone, not burnt clay), and one of clean, sharp sand. It can be measured by pailsful. Any builders' merchant will deliver cement in cwt. bags, and sand or ballast by the load or less. If the handyman lives near gravel pits he will find it easier and cheaper to buy his sand and ballast direct by the load.

Mixing Concrete.—This should be done on a clean pavement or on a wooden platform. The components should be mixed well in the dry state, by turning over with a shovel. The larger material is tipped out first on to the platform, then the sand, and lastly the cement. The heap is shovelled over to another part of the floor, and the ingredients soon become incorporated with one another. A re-shovelling back to the former position

carries the mixing a stage further. Now the heap is wetted from a watering-can, and turned over again. Lest there should be a desire to hurry this part of the process we may point out that the mixture must be thoroughly moistened so that there are no lumps of dry cement left among it; and must be so incorporated that all the crevices between stones are filled with smaller fragments. In turning over the heap the worker will come across "parcels" of stuff that have escaped wetting and are still unmixed; the operation should be carried on until these appear no longer.

The pegs which have been mentioned are driven into the bottom of the trench a yard apart along the centre, and are tapped in to stand up 4 in. A long piece of 2-in. batten with straight edges is used to get a level from one peg to the next and so ensure that from end to end the pegs are level. A spirit-level placed on the edge of the batten will indicate whether the peg should be higher or lower. Start from one end of the trench and work along. The batten should be long enough to span three pegs. Level up the first two, and then rest batten on the second of these—which will be correct—and also on the third, and level up the latter. Proceed in this way to the farther end. In a wider trench the bottom would be pegged in the corners also and along the margins, and levels should be taken across cornerwise, to get the pegs level across the trench as well as lengthwise.

The concrete can now be loaded into a wheelbarrow, and tipped into the trench, level with the tops of the pegs. Failing a wheelbarrow, the handyman could knock up a rough hand-barrow for such jobs as this. It consists of an oblong box of boards fastened on to two lengths of stout stuff which project front and back and serve as handles. Two persons are needed to carry it; but if labour is available and a wheelbarrow is not, it forms a time-saving substitute. The only other method is to carry the concrete in pails to the trench. In any case it will be prepared as close as possible to the place where it is to be used. The concrete can be levelled off with a short piece of batten, working again from the tops of the pegs. The foundation must now be allowed to set.

Mixing Cement.—Lime mortar can be used for our wall, but in some ways cement mortar is easier for the

novice to deal with, and we shall therefore describe its use. The article MORTAR will give hints on mixing and using lime mortar. Ingredients for cement mortar are clean sharp sand and Portland cement. One part of cement in 4–6 may be used. It requires the same care in mixing as was needed for the concrete.

First Job for the Novice.—The bricklaying job we shall first describe is the provision of a support for a rain-water tank for watering the garden. A second-hand galvanized tank can often be got for a shilling or two, or even for nothing, when builders have finished work on an estate and are carting away their plant. Even if it has holes these can be closed up, and a sloping wooden cover is easily made. The tank can stand up 2 ft. from the ground-level and a pipe be led to it from the gutter of an outhouse, or from a down pipe on the walls of the house.

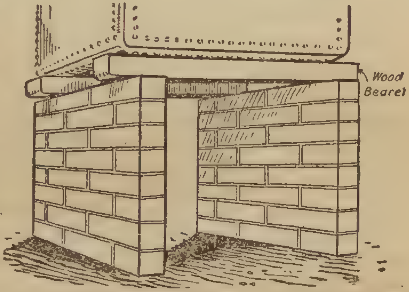


FIG. 1—SUPPORT FOR A RAIN-WATER TANK

In the case of a similar job the writer carried out, there was a convenient location on a concrete path near a rain-water gulley. Two half-brick walls were built up from the path, the proper distance apart; a bed of mortar was laid and the first course levelled up and tested for squareness. The bricks were butted against the house-wall and the walls projected 1 ft. 10½ in. from the latter. Eight courses were laid, each being levelled across the two walls with a straight-edge and spirit-level as the work progressed.

On referring to Fig. 1, it will be apparent that the walls are 2½ bricks long, and the brickbat is placed alternately at front and back ends to "break joint" and form a bond. Each course is spread with mortar, and the bricks as laid are given a dab of mortar on the end to form the internal joint.

A usual size for the cistern is 2 ft. long by 1 ft. 6 in. wide. The depth may be about 1 ft. 8 in., according to the capacity. Two 3-in. by 2-in. deal bearers are rested on the walls when the cement has set firm, and the cistern lies on these. An overflow pipe goes to the nearest gulley, for without this the water would run over the top and make the path and walls damp. If a tap is fitted do not buy one of the screw down kind, which needs considerable pressure to lift the jumper. The sort required is called a "plug" tap. It uses the principle seen in gas taps, having a taper plug with a hole crosswise through it.

Dwarf Wall.—The foundation course is one brick wide, projecting half a brick outside the actual wall; at the ends also it projects to the same extent (*see* Fig. 2). For a wall of the kind we are building the foundation is a single course high, but in the case of a one-brick or 9-in. wall it would be two courses high. The projection broadens the base and so distributes the load over a wider area. Although such considerations do not matter a great deal in the case of a dwarf wall such as we are erecting, they are vital in walls that support weight or form part of a house, or in higher walls like those that form the boundary of a garden.

An examination of the diagram (Fig. 2) on the first four courses (not counting the foundation course) will show that the bricks are arranged so that one overlaps the joint between the two in the course next below it or above it. This is to "break joint." On the face of the wall, no two vertical joints in adjacent courses come above each other. This overlapping forms the "bond"—in the present case termed stretching bond or chimney bond. A bed of cement is spread on the concrete for the foundation course; it should be sufficient to form a layer ½ in. thick. On this are laid the bricks for the foundation course, crosswise to the line of the wall. Bricks placed thus are "headers"; those that lie lengthwise in the line of the wall are "stretchers." The foundation course is levelled with a straight-edge and spirit-level, the bricks being tapped down with the handle of the trowel. The straight-edge, placed against the face of the course, is used to align this and succeeding courses, the bricks being tapped back against it as the work goes on.

Upon this foundation course we erect our wall, working first at the ends, and carrying these up to six or seven courses. Take care that the bond is made correctly by starting 2nd, 4th, and 6th courses with a half-brick, and the 1st, 3rd and 5th with a whole one, as indicated in the diagrams. The brick (8¾ in. long) with its dab of mortar

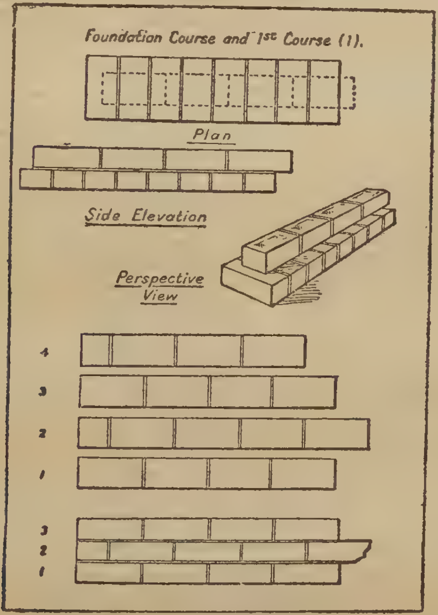


Fig. 2—DWARF WALL

on the end should measure 9 in. and the joint should thus measure ¼ in. A plumb rule is used to test the ends for vertical, being held against the work with the foot and hand, and the bricks tapped in until the bob hangs dead central in the hole and the cord lies in front of the groove in face of plumb rule. The faces also of the wall are "plumbed" in a similar manner.

Brickbats (half-bricks) are cut with a "bolster." The bolster is a broad chisel which is placed across the brick

where the latter has been previously marked, and a blow given with a hammer, first on one side of the brick and then on the other. Then a heavier blow will cut the brick in two. The bricklayer uses a short-handled heavy hammer known as a club-hammer. Unless the bats are carefully cut the courses will not coincide, and the vertical joints of alternate ones will not come directly above each other as they should. These "perpends," as the vertical joints are named, can be tested with the rule as the work goes on. Each course is flushed up with mortar, the joints being filled, and a layer spread to bed the next course. Each brick must have a pat of mortar on its end for the vertical joint. Bricks should be wetted before use, or they will suck up too much water from the mortar.

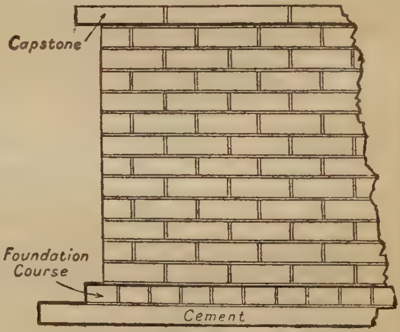


Fig. 3—DWARF WALL

When the ends of the wall have been carried up six courses we can proceed to deal with the intervening portion. We need a line and a pair of bricklayer's "pins." The latter resemble broad-headed nails with thin, flat blades. They are pushed into a joint of the brickwork at the ends and the line stretched tightly from one to the other at the level of the first course. With this as a guide the course is completed, the joints flushed up, and the line moved up to the next course. When the 6th has been completed we can go ahead again with the ends, carrying them up to the 9th or 12th, according to the height desired for the wall, and then using the line and pins again as a guide for filling in.

Treatment of Joints.—On outside walls the surface must be "weathered" so that water will run off and not lodge in the joints. To achieve this end the horizontal joints are "struck"—given a splay from the top edge

outwards and downwards. The trowel is pressed flat against the mortar, beneath the top edge of the joint, so that the surface here is left a little below that of the brick above: the lower edge is left level with the surface of the brick below the joint. Fig. 7 will make this clear. Our dwarf wall and any similar outside work is "struck" on both faces, but if we had built an enclosure, such as

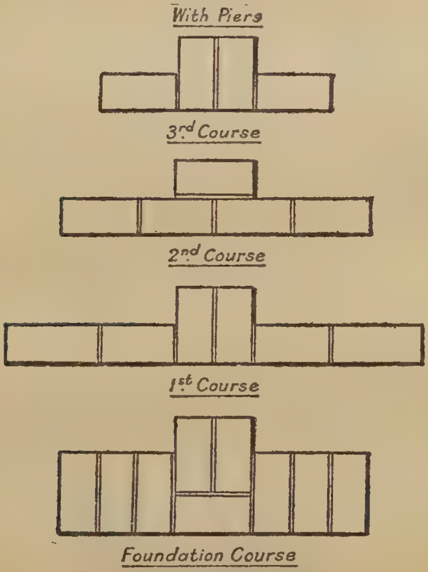


Fig. 4—HALF-BRICK WALL

the base for a conservatory, the inside face would be "flush" jointed, mortar being pressed tightly into the joint and the excess being merely scraped off flush with the brick surface.

Two-in. concrete slabs would form a good capping for the wall, and the slabs are quite easy to cast in simple moulds the handyman can make for the purpose. Instructions are given under the heading CONCRETE. The slabs project 1½ in. beyond the face of the wall.

We will now deal with the case of a half-brick wall

that meets another at right-angles. The intersection is shown in Fig. 5, and also the manner in which the courses differ. The 1st, 3rd, 5th and other odd courses are similar; the 2nd, 4th, and 6th, etc., being alike also. It will be realized that a half-brick must be used in alternate courses, as in the case of the wall earlier de-

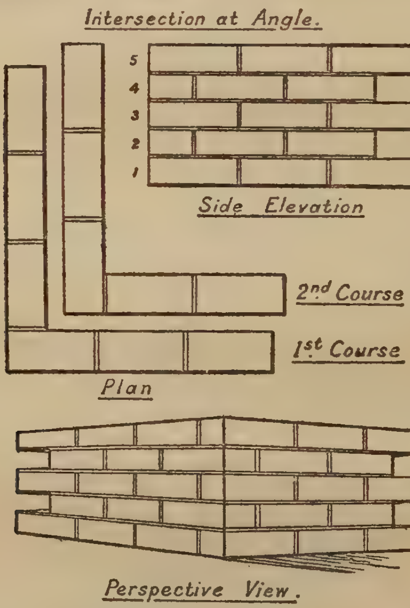


Fig. 5—HALF-BRICK WALL

scribed, but this will be needed in any event to form a "stopped" end, unless there is a return wall at both ends. A half-brick wall that is to be carried up higher than the dwarf structure just mentioned may be strengthened by forming piers at regular intervals in its length. The trench and concrete foundations will be made wider where the piers are to come, and a depth of 6 in. of concrete will be necessary. The foundation course is

shown in Fig. 4, and the arrangement of bricks in the pier to form bond.

The principle of the bond is easily mastered, and no difficulty should be met with in turning out a sound job, if due care is taken and the angles and piers tested with the plumb rule. Aptitude comes only with practice, of

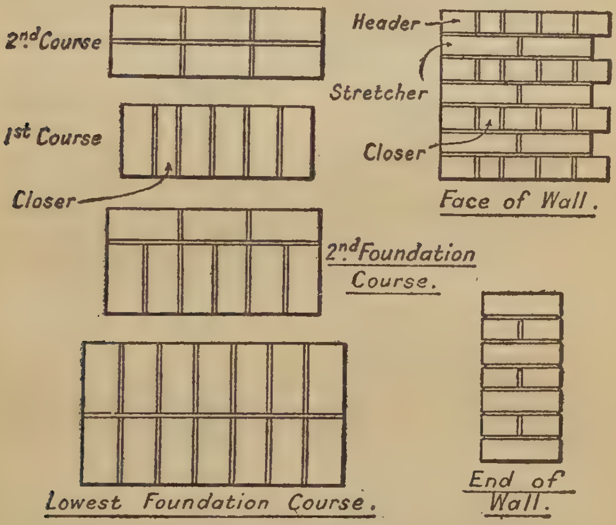


Fig. 6—NINE-INCH WALL

course, but after tackling a simple job, the handyman will feel more at home with his tools and materials.

9-in. Wall.—The trench for a one-brick wall should be 2 ft. 6 in. wide, and two foundation courses are needed. The lowest is two bricks wide (18 in.) and the next course is a brick and a half wide (13½ in.). Fig. 6 shows these, and also the bonding of the wall courses. The bond used in this case is that known as "English," the courses consisting of headers in one and stretchers in that next above it. Note the use of a "closer"—2¼ in.

wide—in each header course in order to break joint. This causes the headers to fall across the joint between stretchers in the course below.

Varieties of Bricks.—For ornamental walls the stock brick or one or other of the facing bricks are desirable. The ordinary building bricks—"Flettons"—are suitable for other constructional purposes, though not so pleasing in appearance. They are not fit for use in paving. A brick measures approximately 8¾ in. by 4¼ in. by 2¾ in., so that when laid in a course it may be taken as 9 in. by 4½ in. by 3 in.; hence the use of the terms 4½ in. or 9 in. in describing the thickness of a wall. Brickwork is measured by the "rod," which contains 272 superficial feet, or 16½ ft. by 16½ ft. 1½ bricks thick.

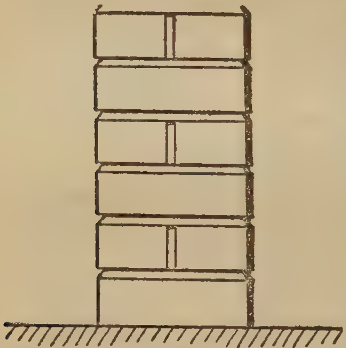


Fig. 7—POINTING STRUCK JOINT

Pillar for Sundial.—The pillar presently to be described would do for a sundial, or could support a bird-bath, the latter being cast in concrete. The pillar is thirteen courses high, stands on a circular base (*see* Fig. 8), and is ornamented with two courses formed of tiles. The pit for concrete foundation is 6 ft. 3 in. in diameter. When the site has been levelled the circle can be struck with a piece of batten and two 6-in. nails. Measure a couple of inches from one end of the batten and bore for a nail, on the centre line of the width. Bore another hole at a point 3 ft. 1½ in. from the first—measuring from centre to centre; insert a nail through the first hole and another to project an inch or two through the second. Having found the centre of the site, by measurement, lay the batten on the ground and knock the first nail into the ground; this forms the centre pivot on which the batten swings. If now we take hold of the other end of batten, press the nail of that end into the ground

slightly and slowly rotate the batten, we shall describe a circle of the required diameter. A rough-and-ready way of marking out a circle is to use a string the length of the radius, with two nails, but the batten method is best.

Dig out the foundation to a depth of 9 in. and fill in rubble or similar material to a thickness of 3 in. Ram this down well and then fill in concrete for a further 6 in. When the concrete is fit to stand on, the base for the

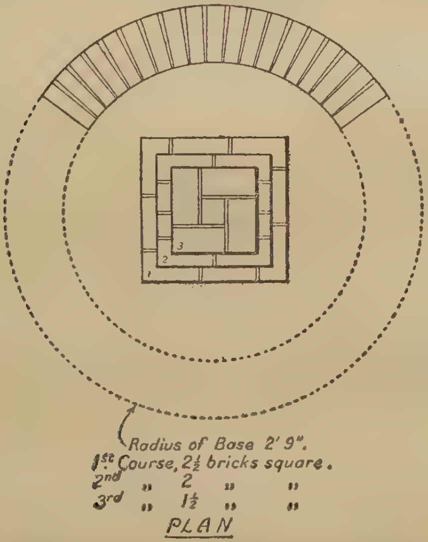


Fig. 8—BRICK AND CONCRETE BASE FOR SUNDIAL

pillar may be commenced. By the way, the level of the concrete will be determined by pegs in the manner already described, but the centre should be marked by a piece of ⅜ gas barrel. Slip a stout nail into this at the top to prevent the bore being filled up when the concrete is being laid; it is to serve as the pivot in marking out the base of the pedestal. On the batten we used to describe the outline of the pit another hole is now bored at a radius of 2 ft. 9 in. from the nail hole that formed the pivot point on the other occasion.

Place the pivot nail in the top of the piece of gas barrel and scribe a circle on the concrete with the nail at other end of batten: this marks the outer edge of the circular base. Using this as a guide, a ring of bricks is laid on edge to form the outer part of the base. Red or purplish facing bricks are very suitable for our purpose, and a pillar carried out in these would be in keeping with any garden scheme. The rest of the base is to be filled with concrete to within an inch of the surface, and on

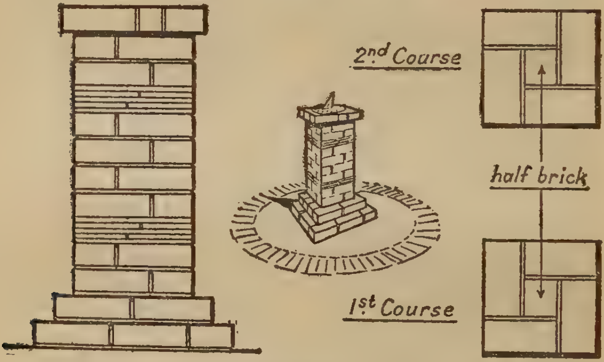


Fig. 9—PILLAR FOR SUNDIAL OR BIRD BATH

top of this will come a layer of cement. The latter can be had in colours, so that the centre might be rendered in a terra-cotta or a greenish cement. Before deciding on the colour mix up a little of the cement with the suggested proportion of sand, and leave it to dry and set. The colour when wet may differ somewhat from the hue the cement has dried out.

When the base has been completed to the handyman's content he may proceed with the pillar itself. As shown by Fig. 8, the first course consists of a square 2½ bricks wide, upon this comes a course made from four bricks —18 in. wide. Thereafter the courses are "brick and-a-half" wide, the arrangement of joints being as indicated in our pictures. After the fourth course comes one formed of tiles, three of these being laid. Next come four brick courses, and then a tile course again.

Two more brick courses follow, and then a projecting course. The latter should jut out $1\frac{1}{2}$ in. all round, and the course is composed of a header, stretcher and closer, the latter making it out to the necessary width. When the pillar has been finished leave it a couple of hours, and then brush down the face of the work with a stiff brush and water.

Should the pedestal be intended for a sundial, a stone cap to project an inch beyond the "oversailing" top course must be prepared; but as this will need to be furnished with means for attaching the sundial plate, it should not be cemented to the pillar until the plate has been purchased. If, on the other hand, the pedestal is to carry a bird bath, the latter can be cast in coloured cement and the job finished.

CEMENT.—The kinds of cement that the amateur mechanic may be called upon to use are many and various, but since the most important of these is perhaps ordinary Portland cement, we will commence by giving a few instructions for its preparation which, if the amateur is inexperienced in its use, may save him a great deal of discouragement and loss of time.

Important points to be observed are the following:

1. The correct proportions of cement, sand and water should be carefully adhered to;

2. The dry materials should be well mixed together, and the water thoroughly and gradually incorporated with them.

Cement may be obtained in several colours, and thus pleasing effects in paving and other work can be carried out.

Portland is rarely used by itself, being usually mixed with sand. The latter should be clean, sharp, dry, and quite free from clay or other impurities. The best proportions for ordinary work are 1 part of Portland cement to 4 or 5 parts of sand. If too much cement is added the mortar is liable to crack; while if the proportion of sand is too great, it will be soft and lacking in strength.

Lay the estimated quantity of dry sand in a heap upon a wooden board or on a stone floor that has been well swept with a stiff broom and is clean and dry. Heap the cement upon the sand and turn over the mass with a spade until the materials are thoroughly blended. Now

make a depression in the centre, which should be filled with a little water; turn over the mass again repeatedly, adding water gradually until the mixture is of the consistency of thick mud. Another plan is to sprinkle the water gradually with the rose of a watering-can.

Cement should be mixed fresh for the job in hand, as it becomes useless a short time after mixing. At the same time, it is well to make a sufficient quantity at once to cover the job, if it is not a large one, in order to obtain uniformity of proportions and therefore of strength. Portland cement should not be mixed or laid in frosty weather, and it is well to bear in mind that it cannot be painted until it is at least twelve months old.

Cement can be preserved some time in a dry state if kept in a closed metal drum, or similar airtight receptacle, in a cool, dry place. Contact with the slightest quantity of moisture, however, will cause the formation of lumps and render it unfit for use. Cement can be bought in 7-lb. bags for small jobs, or in hundredweight bags. For large jobs it is economical to buy it in bulk.

There are several rapid-hardening cements upon the market, some of which will set in 2½ hours or less, while within 24 hours they are capable of withstanding terrific pressure and strain; but these preparations lie properly within the scope of structural engineering. A word may be said, however, regarding the so-called "Roman cement," which actually dates from the end of the 18th century and consists of natural lumps of impure calcareous matter—containing carbonate of lime, silica, alumina, and iron oxide—calcined at a high temperature and afterwards ground to powder. This cement sets in about ¼ hour, but it is not nearly so strong as Portland cement. Moreover, it will not bear dilution with much more than an equal quantity of sand. Both Portland and Roman cements will set under water, and they are therefore known as "hydraulic cements."

There are several cements which rely upon plaster of Paris for their basis. Being affected by moisture, however, most of them are unsuitable for outdoor work, and they are chiefly used for plastering, making moulded objects, and uniting such substances as marble, glass and alabaster. The most important of these cements will now be described.

Keene's Cement, which is made from plaster of Paris and alum, is used for small repairs in plaster work and for making columns, skirtings, mouldings, etc. It does not expand so much as plaster of Paris and also sets more slowly. It is handy for mending holes in plaster about the home.

Martin's Cement, consisting of plaster of Paris and carbonate of potash; it possesses the great advantage of being able to receive paint a few hours after setting. This cement also has a very large covering capacity.

Parian or Keating's Cement.—This is similar to Keene's, with the addition of borax. It will take a coat of paint almost as soon as it has set.

These plaster-of-Paris cements will take a very high polish, almost like that of marble or alabaster. They should be finished off as smoothly as possible with the trowel. For important jobs the surface may then be rubbed down with gritstone, being finished off with snake stone and, last of all, with putty powder.

Scott's Cement.—This preparation, also known as Selenic cement, has the advantage of being suitable for outdoor use, mixed with sand in the form of a mortar, as well as for indoor plaster. A quick-setting cement, it is composed of burnt limestone with about 5 per cent. of plaster of Paris.

A form of cement for repairing cracks and small holes in plaster can be readily made at home. It consists of 2 parts of fine sifted coal ashes, 2 of clean sand, and 1 of ordinary white flour. These should be well mixed together with water and applied with a knife, after moistening the edges of the old work.

Special Cements.—The following are recipes for cements used for particular purposes:

A strong adhesive for stone, earthenware, marble, etc., which is insoluble in water, is made by mixing 1 part by weight of quicklime, 10 parts of dried fresh milk curd, and a small amount of powdered camphor, into a paste with a little cold water. Small repairs in various materials such as glass, ivory, bone, etc., can be made with a cement composed of shellac dissolved in methylated spirit to the consistency of thick treacle.

For mending china, quicklime mixed to a paste with white of egg makes a serviceable cement. The mended

pieces should be firmly pressed together, so as to squeeze out the superfluous mixture. Another china cement, insoluble in water, is made by melting together 7 parts by weight of rosin and 1 part of beeswax, with the addition of a little plaster of Paris. This cement should be applied warm, in a thin coating.

Iron cement is used for rendering watertight the joints and seams of iron pipes, cisterns, etc. There are rapid-setting and slow-setting varieties, the latter being preferable, unless there is any urgency about the matter. The ingredients for the rapid-setting cement are: fine cast-iron turnings, 80 parts by weight; sal ammoniac, 1 part; powdered sulphur, 2 parts.

For the slow-setting variety, the same ingredients should be used, in the proportion of 200, 2, 1, respectively. The ingredients should be well mixed together in a dry state, moistened slightly, remixed and damped with water to the consistency required. Both these cements are hydraulic.

A cement for firmly fixing the tang of a knife blade into the handle is composed of equal parts of fine brick-dust and powdered rosin, melted together. This should be poured into the cavity and the tang, after being heated, pressed well home. A less brittle variety consists of 4 parts of rosin, 1 part of beeswax, and 1 part of brick-dust.

The fireclay slabs of furnaces can be fixed in position with a paste composed of powdered asbestos and sodium silicate (waterglass).

A cement that will resist the action of acid and thus is useful for glass batteries, accumulators, chemical apparatus, etc., consists of powdered glass mixed with sodium silicate to the form of a paste.

For caulking and repairing wooden tanks and as a general waterproof adhesive for wood, use 4 parts of linseed oil, boiled with litharge (lead monoxide), and 8 parts of melted glue; or use a bichromate cement made in the following fashion: A saturated solution of bichromate of potash is poured gradually into hot, melted glue, which meanwhile is kept vigorously stirred. When the mixture turns to a jelly, more glue must be added until it liquefies again, and thus a condition should be gauged when the preparation is just below jellifying

point. The cement should afterwards be exposed to strong sunlight. Only sufficient should be made at one time to serve for the job in hand. To make a saturated solution of a crystalline chemical, as much is put into the water as the latter will dissolve.

A special cement is used in wood-turning for attaching a large article that is being turned to the face-plate of the mandrel. It is made by melting together 4 parts by weight of rosin with 1 part of pitch and then adding sufficient powdered brick-dust to form a stiff paste. The preparation must be used while hot.

Small articles, such as pieces of metal and glass, precious stones, etc., are stuck on to handles while they are being ground. The following is a good cement for this purpose: 4 parts of rosin, 1 of beeswax, and 1 of whiting. The ingredients should be melted together.

A special cement is used by the clever jewellers of Armenia and other regions of Asia Minor for setting jewels and precious stones without employing metal mounts. First make a saturated solution of gum mastic in methylated spirit. At the same time soften some isinglass in cold water, remove any free moisture and stir the softened mass into brandy or rum until it dissolves. Add a little gum ammoniac in a powdered form. Heat these two solutions carefully and mix them together. The resulting solution should be kept in an airtight bottle, which must be stood in boiling water whenever it is required to be used.

Rendering.—The process of covering a wall or floor with a coat of Portland cement mortar is known as rendering. On the walls of houses it is used either as a protection against damp and rain or merely as an ornamental finish, figuring sometimes as an effective disguise when the underlying bricks are not of good quality. When employed as a resistant to damp, a proprietary water-proofing material may be incorporated with the cement in accordance with the makers' instructions.

Rendering is an operation calling for a high degree of skill if it is to be done properly, and the handyman would be advised at first to confine himself to a fairly small job. The finishing of a terrace, drive or small courtyard in this manner may be chosen to start with, since the work is more approachable than the outer wall of a house.

The first thing to do is to clean the existing surface thoroughly and rough it up to receive the rendered coat. The joints of brickwork, if a wall is being rendered, should be raked out with a "dog" or a short iron bar, the end of which is hammered flat and bent to a right-angle. The bricks themselves should also be roughed up with a cold chisel, after which the work must be well brushed with a stiff broom and thoroughly wetted before the first rendered coat is applied. An old concrete floor that it is desired to resurface can be roughed up or keyed with a pick; but when laying a new floor it is usual to roughen up the concrete, before it has set hard, with the point of the trowel. An alternative way of keying a wall is to dash lumps of mortar forcibly against it until the surface is almost covered with an irregular coating. Suitable proportions for this "spatterdash" mortar are 2 parts Portland cement (by volume), 3 parts coarse sand, and 2 parts water. It must be allowed to set quite hard before the rendered coat is applied.

A perfectly flat and level surface can only be obtained by the use of "screeds." These are flat, smooth strips of wood which are fastened to the surface to be rendered and used as guides for levelling the first coat. For screeding the floor, procure some lengths of ½-in. deal about 1½ in. wide and long enough to span the work from side to side, if it is not very extensive. A very big surface, however, is best done a section at a time, the later sections being brought up to the exact level of the earlier ones.

The screeds must be laid flat and parallel and from 3 ft. to 6 ft. apart. They should be bedded on a ¼-in. layer of cement and must be brought to a uniform height by means of the spirit-level set upon a long straight-edge that is laid from one screed to its neighbour. If it is desired—as in the case of a path or carriage drive—to give the work an inclination to one side so as to shed the rain, the screeds must be given a uniform slope in that direction, but in the other plane they must be quite level. If a screed is found to be too low, it should be taken up and have a little more cement thrown in underneath; if it is too high, its height can be reduced by pressure. Time and patience spent on the adjustment of screeds is amply repaid in the appearance and usefulness

of the finished job. They must be left for a day for the cement to harden, before the process of rendering is begun. Narrow concrete paths will not require screeding, for it is presumed that its edging boards will have been left projecting above the concrete sufficiently to form guides for laying the rendered coat.

The cement for our floor may consist of 1 part of cement to 3 parts of sand, worked up with water to a fairly "fat" or sloppy consistency. Thoroughly wet the old work and then spread the rendering coat with a broad trowel, bringing it somewhat above the top level of the screeds. Now take a long, flat piece of wood with an edge planed perfectly true, and resting this edge across two adjacent screeds, work it along gradually, moving each end forward a trifle in turn, so that the superfluous cement is scraped off, leaving a smooth, even surface flush with the top of the screeds. Finishing touches should be given with a broad trowel, using a series of light strokes in a circular direction. When the cement has set, the screeds can be removed by gently prising them at the ends or tapping the ends with a hammer. The shallow grooves that are left are then filled in with cement, trowelled off smooth.

In rendering a wall the screeds must be nailed to the brickwork, after having been packed up underneath to the required height. Two vertical and two horizontal screeds are first attached in the form of a rectangle, a plumb-line being used to ensure that the upright ones are perfectly vertical; the horizontal screeds can be adjusted by means of a line stretched across the face of the work. The wall is thus partitioned off into sections, the screeds being set 3 ft. or so apart. The wall should now be well moistened and the rendering coat of mortar applied; this can be made in the proportions just given for floors. The surplus must be squeezed off with a wooden straight-edge, and the coat left to set. The screeds are then removed in the manner that has been described, and the spaces which they occupied are filled up with cement and trowelled off flush.

A rendered wall is amenable to various kinds of ornamental finishes, some of the most pleasing of which are produced by trowelling the cement in various ways while it is still soft. A very effective pattern is made by

slicing the edge of the trowel into the surface of the cement in an upward direction, leaving a slightly curled edge when the tool is again withdrawn. Other finishes may consist of groups of rounded strokes arranged in symmetrical patterns which the taste of the amateur may suggest. It is advisable not to leave any raised edges or projections of mortar pointing upwards, which would retain dust and moisture, so that all the edges must be "weathered" or given a downward splay.

Directions for mixing and laying or casting concrete are to be found in the article on that material.

CONCRETE.—This important material, which is so universally used for foundations, walls, paving, and cast stone-work of every description, consists of two principal ingredients: the *aggregate*, which may be of any hard material, such as gravel, ballast, broken brick, or clinkers; and the *matrix* of Portland cement or lime, in which the aggregate is embedded, together with a certain amount of sand. The amateur need only concern himself with a matrix of cement and sand, this furnishing the strongest form of concrete.

It is important that the lumps of material should not be too large. The coarsest grade permissible is such as would pass through a 2-in. ring or mesh. This yields a concrete suitable for foundations. For floors and paths and, in fact, practically all the constructional work that the amateur is likely to undertake, the aggregate should be in pieces small enough to pass through a $\frac{3}{4}$-in. mesh; while for castings such as sundials, bird baths and other ornaments, a $\frac{1}{2}$-in. aggregate is suitable. The clinkers and coke breeze for moulding wall slabs should be of a finer grade still, $\frac{3}{8}$ in. being about right. The sand must always be clean and sharp and free from mould or clay, and it must consist of a mixture of both coarse and fine grades.

Thorough mixing is most important for strength and durability in the finished product. A firm platform should be made of scaffold boards; failing this a stone or concrete pavement should be chosen but it must be quite free from garden mould, mud, vegetable matter, or any form of grease. The aggregate must be put down first, and then the sand and the cement are to be spread out evenly in successive order upon it. Porous aggregate,

such as broken bricks, must be well moistened before mixing. In any case, the aggregate must be perfectly clean; and a good plan is to heap it upon an inclined plane, such as a bank or a slope made of planks, and wash it thoroughly with a strong jet from a hose.

The following are some suitable proportions for concrete measured by volume:

For Foundations

Cement	1 part	Sand	3 parts
		Ballast, etc.	6 parts

For walls and cast constructional work

Cement	1 part	Ballast, broken brick, etc.	3 parts
Sand	2 parts		

For floors, garden paths, etc.

Cement	1 part	Sand	2 parts
		Broken brick, etc.	4 parts

For cast blocks in partition walls

Cement	1 part *or*,	Cement	1 part
Coke breeze	5 parts	Sand	2 parts
		Broken clinkers	3 parts

When the correct proportions have been measured out according to the kind of work for which the concrete is intended, the dry ingredients must be turned over several times with a shovel in order to mix them together. Then sprinkle clean water over the heap from a can fitted with a rose, and mix again, turning the mass over and over, right from the bottom. The full quantity of water must be added during the first three turnings and not afterwards. It will vary with the nature of the work for which the concrete is intended, but as a general rule it may be said that for foundations and cast blocks the mixture should be fairly stiff, while a sloppy and semi-liquid consistency is essential for paving, floors and cast constructional work. If the cement is of the quick-setting variety—which by the way is not generally the best for amateur jobs—the concrete must be laid in position in the foundations or structure as soon as possible after mixing.

It is important to remember that concrete must not

be thrown forcibly into the foundation trench or the mould which it is to occupy, since this is apt to cause the heavier lumps of aggregate to settle towards the bottom, leading to lack of uniformity in the strength of the material. Instead it should be tipped or shovelled gently into place and then well rammed down and finished off level to the depth desired. Ramming should only be done while the concrete is in a thoroughly moist condition, and it is always advisable in constructional work where the utmost strength is required, the object of it being to consolidate the concrete and remove hollows and interstices, which in this material are always a source of weakness.

Laying a Concrete Path.—Concrete is perhaps the cheapest and at the same time one of the most durable forms of permanent paving, and since the laying of a garden path is one of the simplest jobs involving its use, the amateur would do well to begin with a piece of work of this kind.

The path must first be carefully planned and marked out with a line. If the ground rises sharply, a single step raising the level at intervals should be allowed for, this being better than giving the path a decided gradient. The soil must now be removed to a depth of 8 or 9 in., and the shallow trench thus formed filled in with hard core to about 3 in. of the top. The filling may consist of broken bricks, large stones, clinkers, crushed tins, pieces of broken earthenware, and any similar hard material in fairly large pieces; it must be well rammed or beaten down and finished off as level as possible. Before this hard core is laid, however, the side framing of the path must be put down. This may consist of lengths of 1 by 4½-in. deal laid end to end, on either side of the trench, so that the top edges of the boards will be flush with the surface of the finished path. These boards should extend a few inches below the top level of the hard-core filling; wooden stakes are driven in against them on the outside and the boards are nailed through. It will be advisable to soak the boards and stakes in creosote and let them dry off before they are fixed in place.

In order that rain and moisture may drain away readily, a slight inclination towards one side may be

given to the path by setting the edging boards on one side a trifle lower than those on the other side. The uniformity of this slope can be tested by laying at intervals across the boards two pieces of wood of exactly the same depth and then sighting across their upper edges. If the two edges appear in line, the slope of the path between them will be constant.

If a very strong construction is not necessary, the excavation may be carried to a depth of only 5 in. or so and filled with a shallow layer of hard core such as broken bricks or of ballast to within 3 in. of the top. To give reinforcement, old wire-netting of not too wide a mesh can then be laid down. It must be raised an inch above the hard core, stretched out flat, and pegged down with pieces of stout wire. This reinforcement would not be required, of course, if the path has the deeper foundation which we have described.

The path is to be laid in sections of, say, 6 ft. each, parted off by joints so as to allow for shrinkage and expansion in varying temperatures, and thus avoid cracking. These sections are formed by setting a tapering strip of wood—such as feather-edge boarding—on edge at intervals between the edging boards. The thinner edge of these boards must be at the bottom, so as to permit of their easy withdrawal when the concrete has set. Fix these boards in place at 6-ft. intervals, either by driving in a wedge between their ends and the inner face of the long edging boards, or by nailing them lightly to the latter, so that the nails can be easily withdrawn when it is required to remove the partition boards. The latter must be quite square with the edging boards.

Now water the hard core with a watering-can and gently tip in the concrete. Work it thoroughly down between the interstices in the hard core and also along the sides of the edging boards, using a wooden rammer to force it into the cracks and corners. Trowel it off level to about 1 in. below the upper edge of the boards, but do not work it to a smooth surface. When wire-netting is being used the concrete must go through and under it, this is why the netting has to be raised a little above the hard core.

The rendering layer of cement mortar should be added preferably after the concrete has thoroughly set,

so as to avoid cracking of the surface; but if the job has to be finished quickly, it may be laid while the concrete is still wet. When the rendering coat is to be applied later, the concrete is left rough so as to provide a "key" for the succeeding layer. In a doubtful case the surface could be scored in a criss-cross manner before concrete is set. It is to be well damped before laying the mortar.

A good mortar is made by allowing one part by volume of Portland cement to two parts of clean, sharp pit sand. Instructions for mixing it will be found in the article CEMENT. It must be well worked into the corners, and should be brought up slightly *higher* than the finished surface is to be. The straight edge of a board, planed quite level and smooth, should now be laid across the two edging boards and drawn along, so as to scrape off the surplus mortar and reduce the surface to a level. Finishing touches should then be given with a large, round-ended trowel.

When the concrete has set, it will be found to have shrunk from the division boards, which must then be worked loose and gently removed. The joints can afterwards be filled up with sand or sifted ashes. The surface of the path must be protected from the sun and from drying winds by being covered with old sacks, and should be watered occasionally for a week.

A step can be made by setting a board on its edge and perfectly upright; it must be planed smooth on the side facing the work. The board is kept in position by stakes at the front. About 3 in. of concrete must be laid in behind the board but separated from it by a 1-in space. Finally, the cement rendering is to be poured in a semi-liquid state into this cavity; the blade of a trowel must be passed repeatedly between it and the wood, so as to get rid of any air-spaces that may be left. When the cement has set, the board can be taken away.

When a large unbroken space—such as a yard or terrace—is being covered with concrete and cement, the area is divided up into sections and dealt with part at a time. It is advisable to lay across it planks, supported at each end on a brick, which straddle the parts already filled in, so as to avoid stepping on the damp surface. Similarly, when trowelling off a rendered coat, the amateur may support his left hand on a plasterer's float

resting on the surface of the cement. If the concrete layer is allowed to set before the "floating" coat is applied, much of the difficulty of dealing with large surfaces will be avoided.

Casting Concrete Slabs for Paving.—An alternative method of paving with concrete is to cast the latter into rectangular slabs, which can then be laid in a similar manner to crazy paving (*q.v.*). These cast slabs can be bought ready made, but the amateur will find it cheaper to make them at home.

The size of the slabs must first be determined; 18 in. by 18 in. is a useful all-round size, while for paving large surfaces 18 in. by 24 in. will prove more convenient. Similarly, a thickness of 2 in. will be adequate for ordinary garden paths, while for heavier construction 2½ in. is more desirable. The amateur must judge for himself, but here we will presume that he is making the smaller size of slab—18 in. by 18 in. by 2 in.

A rectangular frame must first be made out of 2-in. by 2-in. stuff, and of the same size *inside* as that of the slab to be cast. The inside surfaces must be planed quite smooth and the sides must be squarely butt-jointed and firmly screwed together. This frame is then laid upon a perfectly flat and smooth board, free from cracks and joints, and the inside is filled up with cement, which must be pressed well into the corners and levelled off with a flat board or straight-edge. A suitable concrete is made of cement, sand and aggregate in the proportions 1:2:4; the aggregate should consist of gravel small enough to pass a ½-in. mesh. In order to expedite the work, it is advised that quick-setting Portland cement be used. When the slab has set fairly firm, the mould may be removed; owing to the shrinkage of the damp slab this will generally be found quite easy to do. If many blocks are to be cast—as in the case of building slabs, to which this method is equally applicable—it will be found an advantage to have one corner of the frame hinged and the diametrically opposite corner capable of being fastened with a peg and tenon, as is shown in Fig. 1.

The cast slab should be removed on the board on which it rests, so that the next slab must be cast upon another board, several of which should be at hand. When firm enough to be lifted up without fear of breaking, the

slabs may be piled one upon another, but separated by a sheet of newspaper. They should be allowed to harden for several days in a current of air before being used, and must be protected from frost and hot sunshine.

Ornamental cappings for walls and pillars, and also the pedestals of sundials, etc., can be cast in a very similar manner. In all cases, great care should be bestowed upon the construction of the mould, since

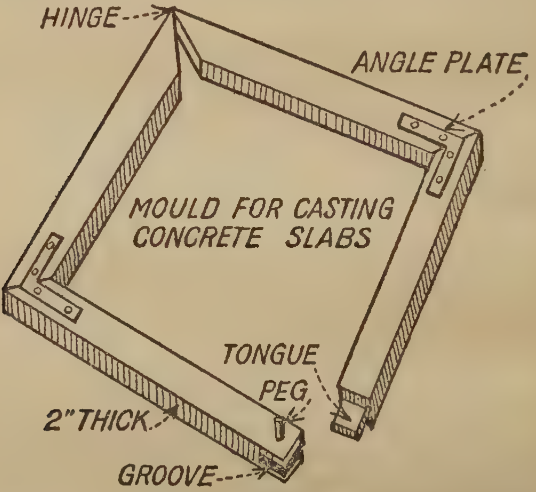


Fig. 1—RECTANGULAR FRAME FOR CASTING SLABS

any open joints, or the slightest roughness or imperfection of its interior surface, will be faithfully duplicated in the surface of the concrete. The square plinth of a sundial will necessitate nothing more in the way of a mould than a square wooden box of the same internal dimensions as those of the outside of the stone it is desired to cast. In all ornamental work in cast concrete, however, special attention must be paid to the surface of the work, which will be marred if any particles of the aggregate or any depressions due to air spaces are allowed to appear on it. Hence it is usual to cover the interior of the mould first of all with a layer of semi-liquid "slip," or gauged mortar,

to the depth of about an half inch, and then to fill in with concrete. If properly done, this assures a smooth, unbroken surface.

Before filling, the mould must be quite clean; it may be oiled or greased slightly all over, in order to prevent the concrete sticking to it, but care must be taken that no grease of any description is allowed to come into contact with any surface that is afterwards to be cemented. Begin by pressing the cement firmly into the corners and along the angles of the mould, taking care that it is uniformly covered to a depth of at least half an inch. When the mortar has begun to set, the concrete may be poured in; it should be in a semi-liquid state, so as easily to fill all corners and inequalities, and should be rammed down firmly. The superfluous material can be levelled off with a straight-edge.

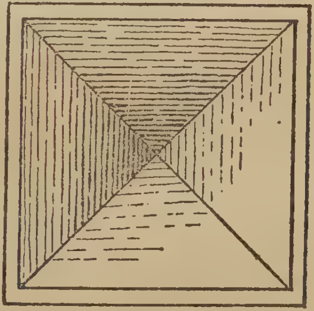


Fig. 2—PLAN OF MOULD FOR CONCRETE CAPPING

A solid casting of a little more difficulty is presented by the ornamental capping of a brick or stone pillar, gatepost, etc. This is usually somewhat like a flattened pyramid in shape, being bevelled four ways from the centre, so as to throw off the rain. The only difficulty, however, is in making the mould, and even this should not present a great problem to the amateur woodworker. Fig. 2 shows a plan of the mould—and Fig. 3 a cross-section; the dimensions and proportions must be adapted to the particular piece of work in hand.

The casting of hollow work, such as bird-baths, ornamental flower-pots, vases, etc., is more complicated, since there is an inside as well as outside surface to be reckoned with and a core must be provided. Probably the amateur may care to try his hand at making a simple square bird-bath with sloping sides. If desired, the inside of the outer mould, instead of being left quite plain, can have strips of three-ply wood or similar

material nailed to it, so as to form a simple design on the sides of the casting. For instance, an oblong piece of three-ply wood can be nailed in and then surmounted with another piece in the shape of an elongated diamond. It must be understood that the design, which stands up on the mould, will be *recessed* into the surface of the finished casting. Small headless brads should be used for attaching these strips.

Cover the inside of the mould with mortar, working it well into the corners of any ornamentation. Embed three or four small pieces of stone or broken tile in the bottom, and on these stand the *inside* mould, which should be of almost the same shape as the outer one, but smaller and slightly more sloping, as will be seen from the diagram (Fig. 4). Before placing it in position, it is as well to run several stout pieces of galvanized wire, bent to shape, across the outer mould from side to side. Each of the four corners of the bird-bath might have an angle-piece embedded in it, an inch from the top, in order to give strength. The inner mould must be placed so that there is a uniform space all the way round, between the two moulds. Now pour in the concrete, which should be fairly sloppy, and tamp it in all round. Remove the *inner* mould when the concrete has set sufficiently, and if necessary, fill up any holes or finish off the inside of the bath with a thin coat of mortar, smoothly trowelled off.

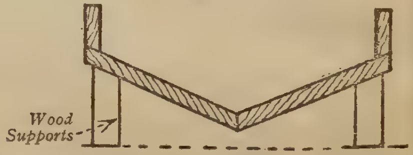


FIG. 3—SECTION OF MOULD FOR CONCRETE CAPPING

A final word of warning is necessary regarding cast work in concrete. For intricate or ornamented work, the moulds must be *screwed* together, not nailed, since the withdrawal of the screws will usually be the only way of removing the mould when the concrete has hardened.

Building slabs for partition walls are cast in a concrete consisting of clinkers and coke breeze with Portland cement, in proportions which we have already given.

The casting resembles in all essential particulars that of paving slabs, as set out above. Quoins, or L-shaped breeze blocks for bonding a corner securely, can be made by constructing an oblong wooden mould as deep as the *height* of the block to be cast and reducing the internal space, by means of a removable wooden block, to the size and shape of the quoin required. Fig. 5 explains how this is done.

The amateur may find that the building of a low wall —about 3 ft. high—in concrete is within his powers, although he is not recommended to attempt one exceeding this height.

A trench for the foundations should first be opened; it should be about 9 in. wide and deep, and must be rammed firm at the bottom. The trench is then to be filled with concrete, as we have already described, as far as the level of the ground. When it has set firm, the shuttering for casting the wall is to be erected. This can be done in the following manner. Stout stakes of appropriate height are driven in, in pairs, one opposite the other at intervals, so that the space to be occupied by the wall lies between them. A piece of wood is then nailed across the top of each pair to keep them equidistant. When spacing the stakes, room must be allowed for a scaffold board or stout plank to be laid on edge on the inside of each stake, so that the opposing faces of the boards will form the mould for the wall, which in the case we are dealing with will be 6 in. thick. The boards should be erected up to a height of 2 ft. or so.

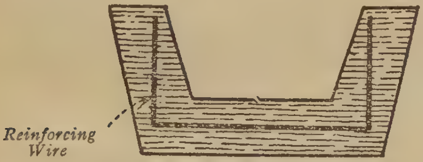


Fig. 4—SECTION THROUGH BIRD-BATH OF CAST CONCRETE

Having got the planks into position just above the ground, and the concrete foundations having been well wetted, shovel in the concrete filling and ram it down, working the trowel between the concrete and the face of the planks, so as to prevent the formation of air spaces. When the work has been carried up to a uniform level all the way along, it must be left for a day or two to harden, protected

from rain, frost and sun by damp sacks. The shuttering can then be removed and carried up another stage, when more concrete can be added, and so on. The work must be well roughed up each time at the top and thoroughly wetted before fresh stuff is added.

Extra care should be taken at bends and angles, which should be reinforced, if possible, by embedding angular pieces of iron in the concrete while it is still soft. The steel slats from an old bedstead, bent to the required angle, and set on edge, one above the other, will fulfil this purpose. The top of the wall can be either rounded off with mortar or finished with a concrete coping, slightly overhanging on either side, and cast in blocks in the manner which we have indicated for paving slabs.

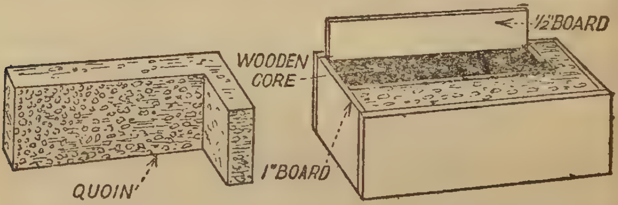


Fig. 5—METHOD OF CASTING QUOIN IN BREEZE BLOCKS

Concrete is admirable for forming the foundations and floors of sheds, coal bunkers and other outbuildings. In erecting a wooden garden shed or poultry house, for instance, the corner-posts and uprights, generally consisting of lengths of stout quartering, may be embedded in concrete. A hole is dug for each post, about a foot square and a foot deep, the bottom of which should be well rammed. The post is now set upright in the hole and the concrete poured in all round and rammed light. It should be brought a little above ground-level. The post needs to be stayed until the concrete sets, and must not be moved in the slightest degree meanwhile.

The floor of the shed, which should previously have been excavated to a depth of 8 in. or so, can be covered with broken bricks or clinkers, well rammed, on top will come a 3-in. layer of concrete. If the aggregate is not of too coarse a gauge, a floating coat of mortar will not be necessary.

CRAZY PAVING.—Being at the same time useful, decorative and extremely durable, crazy paving has become very popular for garden paths. It is by no means the cheapest form of paving, and where appearance is not of prime importance, its place is better taken by brick, gravel or concrete; but as an ornamental path among flower-beds or beside a lawn, crazy paving is unsurpassed. If properly laid, it will last for years; but if not carefully put down it will constitute a perennial nuisance from the unevenness of its stones, bad drainage, and the splashes of mud thrown up by insecure stones in wet weather.

Crazy paving material can be obtained at the stonemason's, and is generally sold by the square yard or else by the ton. Careful measuring of the ground to be covered previous to ordering is advisable in the interests of economy. If the amateur lives near a stone quarry, he may be able to obtain his stone thence at a substantially cheaper rate; but otherwise the cost of transport will put up the price considerably. Stone may also be bought cheap from a building in the process of demolition. Old broken-up steps and flagstones will serve the purpose just as well as virgin stone. The colour of the stone should be carefully selected with reference to the site where it is to be laid. York and Somerset stone are of a pleasing buff shade, which, however, gathers a greenish film if laid in a damp and sunless situation; while Portland stone is a cold grey in hue, but does not easily become soiled. A stone whose upper surface has become broken or chipped can be made quite smooth again by splitting off the superfluous material along the plane of cleavage with a cold chisel.

It is presumed that the amateur wishes to lay down a crazy path between two herbaceous borders or strips of lawn. The edges of the path must be kept as straight as possible and quite parallel throughout their length, and to ensure this, the path must first be fully planned out with a line and marked; a long path over a lawn may be very conveniently marked out with a tennis marker.

Now proceed to cut away the turf and remove the top soil to a depth of 8 in. or more, depending on the stability and drainage of the ground. Ram the soil hard or roll

it well with a heavy roller and put down a layer of broken bricks, large stones or clinkers to a depth of about 4 in. Ram this layer of hard-core tight and cover it with a shallower layer of rubble and small stones which must in turn be rammed down and well rolled, or beaten with the back of a spade. A ¾-in. layer of building sand should now be spread evenly all over the path, so as to form a perfectly level surface, without any sharp points of stone sticking up from below.

Next proceed to lay the stone, commencing with the outer edges of the path, for which those stones that have at least one fairly straight side must be selected. When the edges of a yard or so of paving have been completed to satisfaction, fill in the middle, aiming to get as close a fit as possible between the stones, so that the joints do not take up too much space. As each stone is roughly fitted into its chosen space it must be gently worked about in the sand until it rests quite level, with no suggestion of rocking or tipping. If a stone is too low on one side, remove it and add a little more sand; if it is too high, take away a little of the sand. When each stone has been finally adjusted to the amateur's satisfaction it must be rammed in place with a heavy piece of wood. A length of putlog to which a handle has been fitted makes a good rammer. The stones must "break bond" as far as possible; that is, a joint between two stones should not be in the same line with that between two adjacent stones. The whole width of one section of path must be completed before another section is begun. A line close above the surface will act as a guide to the correct level; it must be stretched tight between pegs driven into the ground at intervals.

If it is desired to prevent or limit the growth of grass and plants in the interstices between the stones, a layer of lime-mortar or cement must be laid, upon which the stones can be bedded; the cracks can then be raked free and filled up with mortar; space may be left, outside the line of tread, in which rock or alpine plants can be inserted. A crazy path should always be cemented together like this if the traffic upon it is likely to be at all heavy. It is recommended, however, that a cemented path should have a slight slope in one direction, preferably towards a flower-bed, so as to permit the escape

of rain-water; in a path whose joints are not filled up this precaution will not be necessary.

If it is intended to carry out a large area—such as a courtyard—in crazy paving, with here and there circular or rectangular flower-beds, the outline of the latter must be formed first, before the rest of the stone is laid. Select thick and heavy stones for the edges of the beds and bed them in cement mortar. The shape of the beds must be clearly and accurately worked out with the line, and all angles must be true and sharp. Circular beds can be marked by driving in a round peg at the centre desired, looping over it loosely the end of a piece of string which is as long as the radius of the circle to be worked and whose other end is furnished with a pointed peg. This is simply drawn round the centre, describing a circle as it goes, the string being kept in a state of tension all the time. Another method of marking—using a measured batten—is described in the article on BRICKWORK.

If the ground over which crazy paving is to be laid is of a very heavy nature and inclined to become water-logged in wet weather, additional drainage must be provided. This is best done by laying perforated drain-pipes in a shallow trench in the centre of the pathway.

A sunken path—such as, for instance, might be made across a lawn—must have its edges firmly bordered with pieces of stone set on edge. The stone edging must, of course, be put in position before the paving itself; it is best to make a narrow cavity for it in the layer of rubble, then to pack the latter close against it and add the sand and finally the paving stones, forcing them tightly against the stone edging. It is important that this edging should be firmly embedded, and in order to prevent its working loose it should be buried below ground for two-thirds of its depth. The top edge must be perfectly level with the lawn against which it is laid, as the least projection will form an obstacle to the mowing machine and prevent the grass from being cut close.

MORTAR.—Bricks or stone are cemented together with mortar, which generally consists of a mixture of lime, sand and water in various proportions.

When increased strength is required, or when it is desired to cover an exposed surface with a smooth, weather-resisting coating, or "rendering," Portland

cement is generally used, and for work of this nature the reader is referred to the information given under the heading CEMENT.

In this article we shall be concerned only with the preparation of mortar for use in brickwork and stonework.

The lime for making mortar should be bought unslaked —as "quicklime," in fact—and for very important work the best hydraulic lime should be used.

The sand can be either of the "pit" or the "river" variety, but in any case it must be clean and sharp, and free from all such impurities as earth, clay or vegetable matter. When estimating the quantities of materials needed, it is useful to bear in mind that about 70 cubic feet of mortar are sufficient for laying a rod of brickwork, and this will necessitate the use of 1½ cubic yards of chalk lime and 3 cubic yards of sand.

First of all, the quicklime must be slaked. Lay it in a heap on a clean wooden platform or on a stone floor, and sprinkle it with water, which will cause it to heat and emit steam. The quantity of water needed for slaking lime varies with the nature of the lime, but is usually a little more than one-third of its bulk. Avoid adding too much water—when fully slaked, the lime should still be quite dry, and it has, in fact, only undergone a chemical change. In order to retain the heat, cover the heap of lime with the measured quantity of sand that is to be used, and leave it under cover for at least twenty-four hours.

When the lime has been fully slaked, turn the mass over several times with a shovel, and then make a depression in the middle into which water is poured. Turn over the mixture again repeatedly, adding water gradually until it is of the consistency of a thick paste. It is then transferred for use to the mortar-board.

Profitable Crafts for the Handyman

CHAIR SEATING.—Many a cane-seated or rush-bottom chair is discarded merely because no one at home knows how to reseat it. Recaning the seat of a chair is not such a complicated procedure as might at first be imagined, and it is well within the scope of the average amateur's abilities. The cane used is Nos. 1 and 2, and while the quantity required necessarily varies according to the extent of the job, two or three ounces should prove enough for reseating one small chair. The split cane must be soaked for a full day in cold water before being used, in order to soften it and prevent it from cracking when it is bent sharply.

Every vestige of the old cane must now be removed from the chair with the help of a strong pocket-knife and a pair of pliers. The little pegs which hold the cut ends tightly in their holes can be driven out with a punch or even a long, blunted wire-nail. When entirely stripped of cane, the chair can be painted, varnished or re-french-polished as desired.

Now take two lengths of the finer cane—No. 2—tie them together in a knot at one end, and lace them up through the extreme left-hand hole in the front of the chair. Throughout the lacing these two lengths must be kept together and treated as one strip of cane; they should lie evenly, side by side, with the polished side uppermost.

Pulling the cane taut, so that the knot presses closely against the underside of the front of the chair, pass the cane across the seat to the back and lace it downwards through the opposite hole. Now pull the cane as tight as possible and keep it so by ramming into the hole a temporary peg of hardwood, a small number of which

should be ready to hand. Then pass the end of the cane up through the adjacent hole and back again to the front bar of the frame, where it is again secured with a peg. This operation should be repeated until the whole frame has been laced from front to back and vice versa, the temporary pegs being from time to time removed from the earlier work and re-inserted into the new. When a length of cane is exhausted, a new one should be started as described in the beginning, or it can be knotted to the short end of the previous length.

The whole operation must now be repeated from side to side across the frame, the strands making a right-angle with the others and being woven in and out, over or under each separate strand. A third set of *single* strands—this time with No. 1 cane—are now made in a diagonal direction, also being interwoven with the ones previously laid; while a fourth weaving, also with the coarser cane in single strands, should follow, this time in the opposite diagonal direction. It will be found necessary to pull out the temporary pegs as the work proceeds and to replace them again after the diagonal lacings have been led through the same holes.

When all the lacing has been completed, drive a permanent peg of hardwood into every alternate hole all round the frame, and snap it off short. The holes are then concealed by a continuous band of fairly broad cane —$\frac{3}{16}$ in. in width will do—which is run all the way round the seat, and is fastened down at every alternate hole which does not contain a peg by a loop formed in a continuous thread of No. 1 cane; the loop is pushed up from underneath, the broad strip is passed through it; it is drawn tight and then pushed up the next hole in another loop, and so the operation proceeds. A careful examination of a chair that has been properly caned will make clear any points over which the amateur is in doubt. When all the cane has been woven, tightly pegged down and finished off, the loose ends may be cut away with a sharp knife. If the chairs, etc., are of the Jacobean style, the cane may then receive a single coat of dark oil varnish stain, lightly applied and wiped off at the edges and the middle, in order to suggest the appearance of wear.

Rush-bottomed Chair.—Re-seating a chair with rushes is also a much simpler job than might at first be imagined. The material used is what is usually known as sea-grass; and, being obtainable in various colours, it provides a cheap, and at the same time decorative, method of re-seating wooden furniture. Moreover, at most handicraft shops one can purchase sturdily-made chairs, stools, etc., of hard wood in the white, which can be stained or painted at home and seated with rushes or sea-grass.

While in re-seating a chair with split cane, as we have seen, the strands are laced through holes in the frame and kept in place by means of wooden pegs, in forming a seat of rushes the material is bound round the rails of the frame, and any other means of fastening is dispensed with. For the sake of an example, we will imagine that we are going to make a rush seat for a small oblong beechwood stool which we have bought in the white and stained and varnished at home.

First of all, take a long, single strand of sea-grass and tie one end of it round the left-hand side rail of the frame, close up against the front leg. Bring the grass straight across the seat to the right-hand rail, making it pass over the rail and down, round the inside of the leg and up and over the right-hand extremity of the front rail. Now lead the grass right across the frame of the stool to the back rail, where it should be made to pass over the rail and down past the inside of the right-hand back leg and up and over the right-hand side rail. It is continued to the opposite rail and so back to the starting-point, having made a complete circuit of the chair frame. The grass should lie close up against the rails of the seat, and it should be kept constantly in a state of tension, being pulled taut after each lacing. Go round again a second time, forcing the strands tightly together. When necessary, knot a fresh length of grass to the short end of the exhausted piece. In order to obtain a simple but pleasing pattern, lace the strands going one way beneath those that cross them at right-angles; and so continue until the seat is entirely filled up with the grass. A pair of fine, long-nosed pliers will be found of use in lacing the grass in and out. The pattern and colours can be varied at will, and many pleasing variations can be arrived at

by experiment. Do not forget to keep the grass taut all the time you are working with it.

As a finishing touch which will keep the grass along each side of the rails from fraying and wearing out, a fillet of thin wood about $\frac{3}{4}$ in. in breadth can be nailed over it; the fillet is bevelled off at the ends so as to fit tightly against the legs.

CHINA REPAIRS.—Ordinary domestic chinaware can be bought so cheaply nowadays that it is seldom worth while repairing broken pieces. If a large or valued piece is in question, however, it is a different matter, and the owner will probably wish to have it made useful or presentable once more. It is not uncommon for the owner to attempt the repair himself, probably using a patent adhesive. If the piece of china is purely ornamental and is kept in a cabinet, such a rough-and-ready repair will often pass muster, but usually as soon as the piece is put into hot water the joint comes apart. When the owner's patience has become exhausted after one or two repetitions of such an occurrence, the broken fragments are often consigned to the dustbin. Yet if the joint had been properly cemented and fastened with rivets, in the manner which we shall describe, the broken piece might have enjoyed many years of usefulness.

The tools for riveting china are very simple and for the most part can be provided at home. They comprise a special drill, a pair of short, flat-nose wire-cutting pliers, a light hammer, such as is used in fretwork, a small triangular file, some brass wire ($\frac{1}{16}$ in. is a useful gauge) for the rivets, and some special china cement, which can be made at home.

Making a Drill.—The drill is of the type that can be worked with one hand alone, and it can easily be made at home. For the spindle, obtain a smooth round iron or brass rod, about 14 in. in length and $\frac{7}{16}$ in. in diameter. A hole must be drilled at about $\frac{1}{2}$ in. from one end to take the tape or cord, and the edges of the hole should be reamed off so that the cord may not be cut when the drill is in use. The other end must be turned in the lathe to a point 2 in. long, in order that it may fit into the tapering diamond bit, which is the most satisfactory tool for drilling china and glass. This bit consists of a tapering tin tube with a straight point

$\frac{1}{2}$ in. long, into the end of which a diamond "spark" is firmly cemented. The diamond bit can be dispensed with, if desired, and a hard steel bit substituted, but in this case the drill must be fed with diamond powder moistened with oil.

If a steel bit is to be used, the end of the drill stock, instead of being merely tapered, must be formed into a chuck in the following manner. The end of the rod has a hole drilled in its centre, $\frac{3}{4}$ in. long and about $\frac{3}{32}$ in. in diameter. Next cut a screw thread on the end of the rod to fit a nut with a milled edge, and then make two saw-cuts at right-angles to one another and about $\frac{3}{4}$ in. long. If the spindle of the drill is of iron, the chuck can be made from a separate piece of brass rod $1\frac{1}{2}$ in. long, sleeved on to the spindle and soldered.

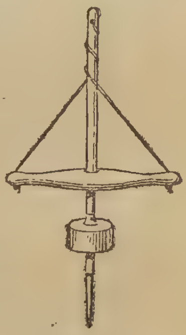


Fig. 1—DRILL USED IN CHINA-RIVETING

The spindle is provided with a wooden arm or cross-bar about 8 in. long, drilled in the middle so that it will pass easily up and down the spindle. A small hole must also be made near each end of the cross-bar through which the ends of the cord can be knotted. About 3 in. from the lower end of the spindle is a cylindrical piece of heavy wood, which serves to maintain constancy of speed when the drill is in action, somewhat after the manner of a flywheel. It should be turned out of box or beechwood, 1 in. in thickness and about $2\frac{1}{4}$ in. in diameter, and should be drilled in the centre with a hole small enough to make a very tight fit with the spindle when it is hammered into place. Now procure a length of cord or tape, thin but strong. Pass it through one of the holes in the cross-piece, through the hole in the upper end of the spindle and through the other extremity of the cross-bar, knotting the two ends securely so that they will not come loose. The cord should be long enough to allow a clearance of about 1 in. between the wooden flywheel and the cross-bar when the latter is at the bottom of its stroke. A glance at the illustration (Fig. 1) will make the

construction of this drill quite plain. To use it, twist the spindle so that the cord is wound up. Now press upon the cross-bar, when the spindle will revolve. When the tape or cord is fully unwound, raise the cross-bar and the tape will again wind itself round the spindle. A little practice is necessary before the drill can be operated smoothly and rapidly.

Riveting China.—The wire from which the rivets are made must be prepared for use by being flattened on one side. This can be done by stretching about a foot of wire along the edge of a stout board by twisting the ends round a couple of nails or screws, and filing it down to about half its thickness with a coarse flat file.

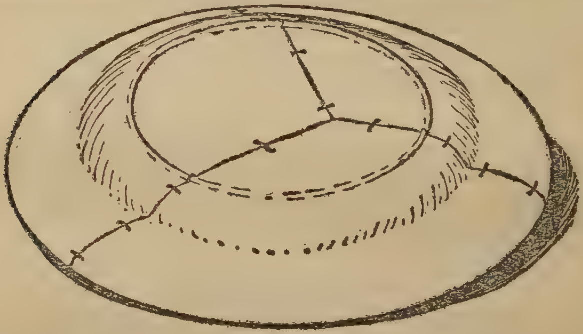


Fig. 2—BOTTOM OF DISH, SHOWING RIVETS

Before beginning the actual riveting, the broken edges must be well washed, then fitted together and the position of each rivet planned out, the object being to impart the greatest strength with the fewest possible rivets. The illustration of a riveted dish, in Fig. 2, will show how the rivets should be arranged for a simple repair of this nature. A tiny spot of paint is useful for indicating the position of each hole. The holes should not be too near the crack that is being repaired; $\frac{1}{4}$ in. away or a trifle less will be found a safe distance, but it must be understood that the length and thickness of the rivets varies somewhat with the size and thickness of the china that is being repaired and no hard and fast rule can be given.

The drill must be operated by the right hand alone, leaving the left hand free to hold the china article, which is supported upon the left thigh, the operator being in a sitting posture. The top of the drill must be slightly inclined *from* the crack, so that each rivet hole is given a slant, and the point of the bit must be freely lubricated with oil. The operator should hold his finger under the hole, in order that he may gauge from the warmth caused by the friction of the drill how far the drilling has proceeded, for it is important that the hole should not be allowed to go right through the china—about half-way through the thickness being usually quite sufficient to afford a good grip to the rivet.

The latter is made by bending the end of the wire back at an acute angle with a few taps of the hammer, the rest of the wire being grasped in the pliers. The bent-back portion should be the same length as the hole it is meant to fit; if it is made the slightest bit longer, the rivet will not lie flat upon the surface of the china. Now measure off carefully the connecting portion of the rivet, bend it again to form another arm and cut off the surplus wire. Finally, tap the rivet into the hole with a few light hammer-blows, or squeeze it in with the pliers. It should lie quite flat upon the surface of the china; if it is too big and will not allow the crack to close properly, it must be withdrawn and replaced with a fresh rivet.

Fig. 3—RIVET IN PLACE

The rivet can now be filed flat and generally trimmed up with the triangular file, and finally the holes and interstices can be filled in with a mixture of plaster of Paris and water. Rivets should be inserted whenever possible in the back of an article, but when it is unavoidable to insert them in a conspicuous part, the whole repair can be tinted with oil colours or water colours to match the existing design.

In repairing a large crack or fracture, a rivet is first inserted at either end, then one near the centre, so as to steady the repair before the remaining rivets are filled in.

Mending Handle of Ewer.—An ornamental jug or ewer whose handle has been broken off can have it attached inconspicuously in the following manner.

After thoroughly cleaning the parts, place a tiny spot of black paint in the exact centre of one of the two pieces that make up each joint. Carefully press the broken parts together; and, on separating them, the centre of each of the other parts will also be marked in paint. A ¼-in. hole must now be made exactly on the paint mark. In the meantime a wire dowel is to be prepared, about ½ in. long. It must be quite straight, and should have its ends notched with a hacksaw or roughed up with a coarse file. Carefully insert a little plaster of Paris cement—made by mixing the dry plaster to a thick cream with cold water—into each hole and thinly smear the broken surfaces of china with flake-white oil colour. Insert the wire dowels and press the broken handle firmly into place, retaining it with elastic bands or strips of adhesive plaster.

Though flake-white makes a very strong and water-tight joint, it takes rather a long time to become quite hard, and so the repaired article should be set aside for several weeks. A cement that dries hard in a few hours is made by dissolving isinglass in acetic acid, but the adhesive will not stand immersion in hot water. Instructions for making other cements for mending china, glass and earthenware will be found under the heading CEMENT: SPECIAL CEMENTS.

CLOCKS: CARE AND MAINTENANCE.—Many a home mechanic has had cause to regret his temerity in meddling with a clock, and indeed, unless and until one learns something about them, the inside is best left alone. Even then, there are some the amateur can deal with and others he should leave absolutely alone. However, clocks fascinate most people of a mechanical turn of mind, and the handyman can cause no tears by tinkering with a cheap Swiss or American 30-hour drum clock when it comes to the stage of stopping intermittently or altogether. In this article we will discuss the care of the clocks that are generally to be found in the home.

French Clocks.—These are usually in marble or gilt cases, fixed by a clamping-screw arrangement in the circular hole at front and back of the clock-case. The movement itself has circular plates and is pinned on to the dial frame. From the back of the bezel or ring of the face there are two brass arms or bars that go through

the case to the back, where they are fastened by long screws that go through two holes in the door bezel. The bars are bent over here at right-angles, and the short angle ends are bored and threaded for the clamping screws. It should rarely be necessary to remove the clock from its case, but it is done by first loosening and then withdrawing the two screws, when the back ring to which the door is hinged will come away and the front bezel and dial with movement attached can be removed from the front. The pendulum, of course, should be unhooked and removed first, taking care not to alter the position of the regulating nut at lower end, or in the centre of the pendulum boss.

We will assume that the reason for taking out the movement was a looseness of the standard to which the coiled steel wire gong is attached. This latter is fixed through the base of clock-case by a screw thread and nut, and now that it is accessible it can be tightened up in the proper position. The wheels of a French clock are very fine, with needle-like pivots. The workmanship is usually of the best, and the clocks go well for years and then only need a periodical cleaning. This is one of the clocks that should not be tampered with: if curiosity has impelled the owner to take the movement out of its case, let him replace it gingerly and with care.

The clamping screws sometimes become loose and allow the movement to twist round slightly when the clock is wound. The effect of this twist is to put the pendulum support out of vertical and to put the pendulum out of "beat." Instead of a steady and even "tick-tock, tick-tock," or "tick, tick, tick, tick," that marks a clock standing level and a pendulum in beat, we get a "tick—t-o-c-k, tick—t-o-c-k," the first sound short and sharp and the second one longer. To a "clocky" man such a tick is very irritating wherever and whenever he hears it. The writer on a visit to the physician heard from the upper regions such a tick of distress, and after the business of the moment had been done he got permission to investigate. The culprit was a fine old long-case or grandfather clock that was not standing level; in a minute it was set right and in beat, but for want of a friendly touch it had stood out of beat for best part of a year.

To return to our French clock, the movement must

be carefully twisted, a fraction of an inch at a time, until the tick sounds even and regular, the clock being placed meanwhile on a level surface. Then screw up the two clamping screws, a few turns to each alternately, until the case is gripped by the flanged ring. Sometimes the thread becomes worn away in the angle of the clamping strips and the screw will not bite. The remedy is to tap a slightly larger thread of a standard size and insert a cheese-headed screw to fit. The small screws used by model-makers are suitable. Failing this, a nut of a suitable standard size might be soldered to the clamping strip at the angle, and the screw used in the ordinary way. In the latter case the hole in the clamping arm must first be reamed out large enough to permit the screw to pass through and enter the nut. It is usually not possible to fit a nut to the existing screw. Occasionally the end of the clamping arm gets twisted round and broken off. The remedy here is to make another end out of thin, stiff brass, long enough to reach to the break and lap over ½ in. at the joint. It is soldered on, taking care that the angle piece is square and facing the right way.

The regulation of French clocks is sometimes a bother. The pendulum rod is so short that even the tiniest movement of the bob up or down has a considerable effect upon the timing of the clock. It is best, before altering the screw, to look at the slide through a lens and make a fine pencil mark or a scratch with a scriber to indicate where the top of the bob comes. Then the amount of movement given to the slide can be gauged to a nicety. Unless we have some such mark to start from, the mere twisting of the screw to right or left at an interval of a day is almost useless; nine times out of ten we shall give too much movement to the slide, and then, to correct it next time, overshoot the mark as much in the other direction. Many French clocks have a regulator working on the pendulum suspension, with a squared spindle projecting through the dial which is turned with a key for "fast" or "slow." As a rule, however, the action of this device is uncertain and the teeth of the wheel work very loosely in the pinion, so that it is almost as speedy to take out the pendulum and regulate it by the knurled screw on the rod.

It will be noted that the pendulum hangs by a slotted hook to a spring "suspension" (Fig. 1) which is pinned in turn to the slotted pendulum cock above. The spring is very delicate and fragile; if the pendulum is twisted in unhooking it, irreparable damage may be done to the spring. A new suspension can be got from the local watch repairer for sixpence or less; it should be of the same kind as the old one it is to replace.

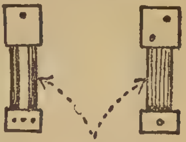


Fig. 1—SUSPENSION SPRINGS

Striking Mechanism.—When setting the hands of any striking clock some care is needed. Many French clocks have a "snail" on the hour wheel beneath the dial, and a toothed rack for controlling the strike (Fig. 2). In such clocks the hands may be turned forward at all times up to twelve o'clock without waiting for the striking at each hour and half-hour. At twelve, however, the clock must be allowed to strike before the hands are again moved. It is the minute hand only that should be turned. In French clocks of another, older type there is a notched circular "locking plate" (Fig. 3) at the back of the movement, connected to the striking wheels, and the hands must be turned forward half-hour by half-hour, allowing the clock to strike at each period. Do not turn back the hands of *any* striking clock. If you wish to set the time back, rather stop the clock and wait until the desired hour is nearly reached, when the hand can be set forward to the exact time. If the clock strikes at the wrong time, turn the hour-hand until it points to the correct time.

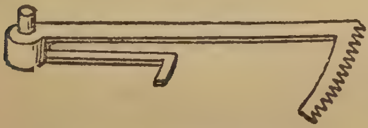


Fig. 2—STRIKING RACK

A chattering of the hammer on bell or gong or a dullness of sound in striking denotes that the hammer-wire needs to be adjusted to put the hammer a little farther away from the bell or gong. The hammer-head is perhaps secured to the shank by a set-screw that permits alteration when loosened; it may need a twist to one side or the other, or the wire may require to be bent back

carefully a little. Use two pairs of pliers for this: grip the shank some distance away with one to hold it firmly, and bend the wire with the other. The post of a gong may be loose and the gong may need twisting inwards or outwards slightly, or, as we said, the hammer-head with its fibre pad may require a twist. Adjustments are tested by causing the clock to strike, for it is no use merely to lift the hammer and let it fall again. In a clock striking on a bell, see that the latter is tight on its bracket and that the nut is not loose.

It may happen when setting such a clock in beat that when the tick is at last satisfactory the clock has had to be twisted round so far that the XII and VI are no longer vertical. This is an ugly business, and we must correct the beat in another way Turn the back of the clock towards you so that you can see the pendulum. It swings in a notched "crutch" that embraces the rod (Fig. 4). Twist the clock movement back so that the XII and VI are vertical; now lift up one side of the case and raise it by a wedge of folded paper. Note if this improves the tick; if it makes it worse, move the wedge to the opposite side of the clock base. Increase or diminish the thickness of paper until the clock is in beat. Now remove paper wedge, take out pendulum, and bend the wire of the crutch slightly sideways at about a third of its length from the top, holding wire with one pair of pliers above and bending with the fingers or with another pair of pliers.

Fig. 3—LOCKING PLATE

The bending must be *towards* the side that had to be upraised by the wedge, and a very slight inclination to one side will usually suffice. If the wire is bent just the correct amount, the clock will be in beat when it stands level, and the dial will also be upright. In some clocks of the kind the crutch is only friction-tight on the spindle, and the clock can be put in beat by giving a

swing to the pendulum. Much trouble is occasioned through dusting operations. It should be laid down as a rule that pendulum clocks are not to be moved for dusting purposes. The least that can happen is that the clock is stopped, perhaps for a minute or so, and started again by a lift or a shake. The moving of the clock, however, may set it out of beat and occasion trouble in that respect. Regular winding is essential for good time-keeping.

Gilt clocks that are provided with a glass shade are dealt with in a similar manner to other French clocks, and these especially should not be moved more than necessary. Sometimes they tend to lean to the back or the front, so that the pendulum is canted and may knock against some part of the case. This can be corrected by a tiny wedge under the ornamental feet at front or back, as the case may be. A similar trouble is found occasionally in marble-cased clocks when the bracket or mantelpiece slopes backward. It is cured by a wedge under each side of the base of the clock at rear only.

Fig. 4 — CRUTCH OF FRENCH CLOCK

Kitchen Clocks.—The best clock for a kitchen is the English eight-day "dial." This is the round clock one often sees in shops and offices. The dial *is* the clock, one might say, for the movement is pinned to the dial, and is encased in an oblong box attached to the frame of the clock-face, usually by wooden pegs. In order to examine the movement the pendulum is taken off, the bezel is opened, and the hands taken off; the minute hand is fixed by a collet and a pin, and the hour hand usually is fixed by a small screw to the sleeve of the hour wheel. Next the clock is laid face down and the pegs taken out that fasten the box to the face. It will be observed that the movement is held to the dial by posts that pass through holes in the front plate: take out the pins from the posts and the movement will come away from the dial.

One of the most common troubles with such a clock is breaking of a gut line. English eight-day clocks are

robust and well made: it is seldom that anything more than cleaning is called for. The motive power comes from a spring in a barrel, connected to the wheels by a cord that passes around a grooved conical "fusee." The spindle of the latter has a winding square, and on the other end is the main-wheel that drives the clock. A similar arrangement is found in some English watches. Sometimes it is a chain that connects spring-barrel and fusee.

In replacing a gut line, the fusee will have to be taken out and taken to pieces, for one end of the line must be threaded through a hole in the fusee-shell and knotted on the inside. Though it might be possible to insert the other end into the barrel, without removing the latter, it is as well to take out that part as well when the fusee has to be dealt with. The "motion work" (wheels for driving the hands) will be removed before the rest of the movement is taken apart. Notice how the gut winds on to barrel and fusee before removing anything, as this will save a lot of pondering later. The barrel, through its spring, is normally in a state of tension all the time, even though the clock may have run down, for the spring is "set up" a turn by a method to be explained presently.

When the gut broke, the spring unwound to its full extent and, in its state as we now deal with it, is slack. When the fusee has been removed from plates, the main-wheel is taken off by sliding out a springy piece of brass that fits in a notch on the spindle, and lifting off wheel. Sometimes this retaining piece is screwed on or pinned to the spindle. Beneath is a recess for the knot of the line. In this part of the fusee is contained the ratchet action that allows the clock to be wound. When cleaning the fusee the position of the components should be noted, so that no difficulty is encountered in reassembling them. After fixing cord, oil the ratchet and replace main-wheel. The rest of the gut is wound round the barrel and the end secured to the latter. The manner of looping gut is shown in Fig. 5. The line goes in at the nearest hole of the three, passes under and up through the middle hole, then down through the farthest hole; the end is now passed through the loop made by the gut beneath first and middle holes, and the tension here holds it taut.

The ends of the gut are "mushroomed" by searing them with a hot iron. This expands the end and stops it from coming undone.

After barrel and fusee have been put into place, the spring must be set up. The click is screwed to plate and the toothed wheel placed on barrel-spindle and pinned. Place the winding key on the square of the barrel-spindle and, the click being loosened, turn the spindle so as to wind up the spring a half or three-quarter turn—just enough to tauten gut and keep it in tension. Place click in a notch of the ratchet and screw up tight. Test the adjustment by winding up fusee and thus winding spring in its barrel. See that gut winds on to fusee properly. A stop is fixed to the latter which should prevent overwinding.

Fig. 5—FASTENING GUT

Cleaning the Clock.—If the clock needs cleaning, this may be done before reassembly of the parts. Note that when taking clock to pieces the spring must first be allowed to unwind. Let the clock run down; then grip the square of barrel-spindle with a hand-vice, loosen screw of click, and allow the barrel to turn round gently until slack. If the line has broken, as we said, there is no need to let down spring in this way. The plates and wheels are brushed with whiting and water or with rottenstone and oil, which is then brushed or rubbed off again. Next the parts are cleaned with petrol or benzine—this job should be done out of doors—and all traces of the polishing material thus removed. Since the latter is an abrasive, it would not do to leave any in the bearings, where it would set up friction and grind away the pivots. The pivot holes are cleaned by twisting into them wooden pegs and thus scraping out all foreign matter.

Oiling.—At each pivot hole will be noticed a hollow or countersink for retaining oil. Proper clock-oil should be used, and never a thick lubricating oil, for the latter would thicken up and stop the clock. An oiler should be made from a piece of thin wire by hammering out one

end to flatten it. Dip this into the oil and drop a tiny amount into each countersink; put a little on the pendulum slide and on the rod where the latter rides in or on the crutch. The pendulum rod is usually a flat one, slotted to take the pin of the crutch. Avoid any excess of oil here. A touch is wanted on each of the pallet faces and on the "cannons" or sleeves of the motion work. Do not forget a drop of oil on the nut of the pendulum-regulating screw. The fusee needs oiling, and, as we said, it should be dealt with whenever it has to be taken out. A little of a thicker oil may be injected into the barrel to lubricate the spring.

Long-case Clocks.—Grandfather or long-case clocks are met with in two main types. One has a thirty-hour movement with a single weight working on an endless cord or chain. The other is fitted with an eight-day movement with two weights having lines that are wound up on their barrels by turning a key. The thirty-hour has been well called the farm-house clock, and many are still to be seen in cottages and farms to-day. The hours are struck on a large bell, and the single weight on its cord or chain drives both the going train and striking train. The pulleys attached to the main-wheels are each furnished with a ratchet: they are thus free to revolve by themselves in one direction, so that the weight can be drawn up by pulling down the loop of the endless cord or chain; in the other direction the ratchet and pawl ensure that the weight, acting on the spiked pulleys, drives the main-wheels and so imparts motion to the train.

The cord used for these clocks is a special open-woven one that engages with the spikes of the pulley and yet does not readily fray; it can be obtained from a clock material dealer, or the local tradesman would order it for the handyman. Note that the loop of the cord must be kept taut by a small and not too heavy leaden weight. This may be angular or ring-shaped, the cord being threaded through it when first fitted. Or it can be hung on the cord by a ring, the ring being opened and afterwards closed. This loop must come to the front, clear of the driving weight. The latter hangs from a pulley, and the cord goes from this to pass over the pulleys on the main-wheels. A diagram (Fig. 6) is given to make

clear the manner of threading the cord, which has to be sewn end to end after this has been done.

Sometimes a new chain has to be fitted to a clock of this description; on taking a few links to a clock-material dealer a new length can be obtained or will be made up to order. The links are of a peculiar shape which varies with different clocks. Ordinary chain is useless for the purpose. The new chain is threaded in the same way as a cord—first through the ring-weight, where a temporary fastening is made, then over the right-hand pulley, down and under pulley of driving weight, up and over left-hand pulley, and then brought down to join the end that was threaded through ring-weight. See that the final downcoming end is brought in front of the cord or chain going to the driving pulley. The chain is connected by opening one end-link, hooking it to other end of chain, and then carefully closing it. See that the link is not deformed by this manipulation.

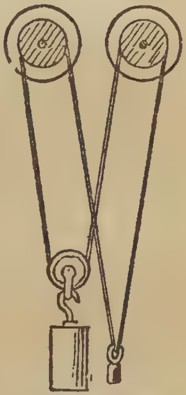


Fig. 6—ENDLESS CORD

When winding the clock, do not draw up quite to the top; and perform the operation gently, partly supporting the weight meanwhile. The chain may have a little thick oil applied occasionally. Should the chain at any time become kinked, open a link near the spot, separate the ends, straighten them, and connect again. Pull up the weight first, so that the kinked portion of the chain comes lowest. A drawback of chains is that they are liable to "hang-up," and later to loosen with a jerk. If a chain has to be threaded on while the clock is in its case, reach up and hook one link over a spike at top of pulley; then turn pulley with the finger until an end of chain comes down far enough to be seized and pulled upon.

Thirty-hour long-case clocks have usually a painted dial, and the cases are inclined to be large and somewhat clumsy. They are good timekeepers none the less, and well worth regular care and overhaul. Older clocks are

less commonly met with that have brass dials and the movement enclosed in a "cage" instead of being fitted to plates. It is a rarity to find these in going order or in a state capable of repair. The dials of some are of the one-hand variety, but the age must not be over-estimated on this score, for such clocks continued to be made for country use long after the use of the minute hand became common. If the movement of such a clock is past repair, the old brass dial is worth preservation. Besides the long-case clocks on this principle, one sometimes comes across a hanging or bracket clock with weight and pendulum depending beneath. Often such clocks have an ingenious "alarm," driven by a small separate weight. The alarm can be converted to an electric one with little trouble, the clock merely operating a contact or switch.

The cleaning of a thirty-hour clock is within the scope of the amateur; the hands should be unpinned, the dial feet unpinned from the clock plate and the dial taken off. Beneath are found the motion work for the hands, and when these wheels are removed the plate can be unpinned and taken off, and the rest of the wheels released. It is a good plan to place all pins, collets or washers, clicks and similar small parts in a little tin box where they will not be mislaid. The plates and wheels are brightened and polished with whiting brushed on and then cleaned off. The clockmaker uses "rottenstone" and oil as the cleaning medium. A fine stiff brush is needed to clean the teeth of wheels and the "leaves" of pinions. If the "arbors" or spindles are rusted they can be rubbed with emery cloth. The polishing material is cleaned off with benzine or petrol—this being done in the open air away from any flame, and remote also from the open doors or windows of a room in which a fire or a gas-ring may be alight.

The pivot holes are cleaned by twisting into them a sharpened wooden peg. Be careful, when cleaning wheels, not to loosen them on their arbors. After the clock has been assembled and before the dial is put on, put a drop of oil into each hollow of the pivot holes, and a little on the ratchets of pulleys. A tiny amount is needed also on each pinion. Do not forget to put a little oil on the faces of the pallet and in the hole in pendulum bridge at the back of the clock.

The pendulum rod should be looked to and made straight if necessary. Put a little oil on the slide and on the regulating screw and nut. Oil is needed also where the pendulum rod works in the crutch. See that the pendulum cock is square and that the slot is not too loose. The suspension spring, if bent or twisted, should be replaced by another, if possible; if not, a careful attempt might be made to restore it to its proper shape. Soften it in a flame, draw it between flat-nosed pliers to straighten and flatten it, and then retemper the spring by heating, letting down to a purple colour, and quenching. Often the pendulum in these old clocks has suffered considerably, and it is then worth while making up a new one, at least as far as the rod is concerned. On another page we give the lengths of pendulum for different types of clock. That for the long-case clock is known as a "seconds" pendulum, since it beats once per second.

Eight-day "Grandfather."—The following remarks are applicable to the long-case clock, but it many respects the English bracket clock movement is very similar, except that its motive power is derived from springs. The eight-day clock is *not* one that the average amateur should attempt to repair, though there are simple replacements and adjustments that he may deal with. One of the most common is the fitting of new gut-lines to the weights. The pendulum is unhooked from its cock, the movement taken off the seat-board and the hands and dial removed. It may now be possible to get at the barrel and take out the end of the broken line. First notice carefully how it is twisted or knotted to secure the end after it passes through the hole in the barrel; the new line will have to be fastened in a like fashion.

A new length of gut having been procured in readiness, one end is seared with a hot iron to expand it, and the opposite end is threaded into barrel and out of the hole in its periphery. The seared end is fastened inside barrel, where the enlarged end prevents the knot from becoming unfastened. Now the line passes on top of the barrel, under pulley of weight, and up to and through a hole in the seat-board, where it is fastened. Any doubt as to the arrangement of gut can be prevented by a careful inspection of the remaining part of the line

before the latter is taken out. It is not worth while to try and make the old line "do," even if the line has broken quite near the barrel. If replaced it will probably break again when the clock is being wound.

The cleaning of an eight-day movement has already been described on page 279. The striking clock is more complicated, for the wheels have to be replaced in the proper order so that the strike is correct, and on this account we do not recommend the home worker to attempt it—at least until he has familiarized himself with the theory of the mechanism. An account of this is rather outside the scope of the present volume, but a handbook on Clock-Jobbing can be got through a bookseller for a couple of shillings if further information is desired.

Pendulums.—A pendulum to beat every second, in the latitude of London, must be 39·14 in. long, approximately. This length is measured from the point where the pendulum is supported to a more or less imaginary point called the centre of oscillation. For practical purposes, in pendulums with a lens-shaped bob, the second point may be taken as the centre of the disk of the bob. It will be clear that the actual pendulum rod must be longer than this by half the diameter of the bob, plus a portion at the end, which is screwed to enable the effective length of the rod to be varied. The suspension spring is of course included in the effective length.

The pendulum is regulated by lowering or raising the bob on its rod, by turning a milled screw. The least amount of alteration possible depends on the pitch of the thread; a thread of 50 to the in. would permit an adjustment such that the clock would lose or gain about 3½ minutes per seven days. We might get a finer adjustment by using a screw thread of finer pitch, but this would be tiny and fragile and not a mechanical success. An alternative is carefully to solder a disk—a coin for instance—to the face of the nut and to divide it into degrees of arc by lines radiating from the centre, where of course a hole is drilled. A very light pointer is made of thin brass, fixed to the bob, and bent down over the edge of the disk. Now we are able to measure on the face or edge of the disk a half or a quarter turn, and the

timing can be made more fine, for we need only raise or lower the pendulum bob to that extent.

This matter has been explained at some length, since it affects the regulation of all pendulum clocks. The shorter the pendulum, the coarser its timing must be. A pendulum to beat half-seconds must be only 9·78 in. long; to beat quarter-seconds the length is only 2·45 in. The law governing the length is as follows: the time of beat or vibration is proportionate to the square root of the length of the pendulum. If we wish to double the time of beat we must quadruple the length. It will be obvious that in timing a French clock, for instance, a fine adjustment demands the most minute alteration of the screw. That is why the usual regulator operated by a key seldom gives satisfaction, on account of looseness and "back-lash" in its engagement.

Drum Clocks.—The cheap and useful 30-hour alarm clocks or timepieces come to a stop generally through friction. The oil hardens, and dust settles on the pivots and bearings and becomes mixed with it. If this is not the trouble, then it is usually lack of oil. Here we might usefully point out that an excess of oil on any type of clock is as harmful as too little, for it runs down from the pivots or spreads out around them and traps dust particles. If a drum clock stops and no obvious defect can be found, such as a broken mainspring or a crippled hairspring, we may try a Spartan remedy.

Take off the dial and hands; now stand the movement in a dish or tray—out in the open air—and inject petrol or benzine into all the bearings with a glass syringe or one of the squirts that motorists use for a similar purpose. The idea is to dissolve and remove any congealed oil, and to free the wheels and pinions of dust adhering to them. Leave the clock out of doors until quite free of spirit, when a trace of oil can be put on the pallet faces, and in each pivot hole. The coils of the mainspring can receive a thicker oil; the clock pivots need a proper clock oil or a substitute made by diluting good sewing-machine oil with half the quantity of kerosene. Wipe off any surplus oil before putting the movement back into the case; it making this replacement, guard against harming the balance wheel by handling or by pressing it against the case.

The cupped screws that form the bearings for the pivots of the balance-wheel should be looked to and tightened if necessary. A very careful and minute adjustment is called for here. At this point an excess of oil will easily cause trouble, but the cups need a sufficiency, and must not be allowed to become dry. The screws are turned with pliers or with a tiny spanner. One of them usually serves also to secure the index of the regulator. The latter has a loop around the last coil of hairspring, and it operates by altering the effective length of the latter. The shorter the spring, the more numerous the vibrations, and the faster the clock goes.

CLOCK CASES, REPAIRING.—The home mechanic who combines a taste for metal working with some ability at cabinet work can find an interesting—and profitable—use for his leisure in reconditioning the cases of grandfather clocks. We have elsewhere dealt with the mechanism of these fine old relics of a past century, and here we propose to outline some of the more usual and simple repairs to the case.

In country towns one may pick up a thirty-hour long-case clock for three or four pounds. Though the mechanism is rougher than that found in eight-day clocks it is excellently fitted for its purpose, and a clock of the type is an asset in any home. The case is often in sad condition: the base shows cracks; feet are damaged; mouldings loose or broken away. The hood enclosing the movement may be rickety; hinges are defective, ornaments broken off, or joints parted. The back, one finds to be split; the door crippled or warped; the ends of the trunk where the seat board rests are perhaps split by nails driven in for a rough-and-ready replacement of the board after repairs to the movement. The fillets and moulding on which hood slides are another part where damage may be found.

The whole case, in fact, may be in such a poor condition that the worker almost despairs of making it sound again; though the defects, in the mass, seem almost unmendable, we can tackle them one by one and eventually restore the old servant to something like his former glory. First we must deal with the repairs necessary to stability and firmness; those connected with mere appearance will come later. Take

off the hood and put it aside out of harm's way, the glass towards the wall. Remove pendulum and carefully prise off seat-board if it is fastened by nails driven into ends of the boards forming sides of trunk. Should the seat-board, however, be attached very firmly or strongly, let it remain and take off movement by undoing the nuts, beneath, of the hooked bolts that hold down movement by the two lower pillars.

Take the case out of doors and give it a complete dusting. If one is available, a vacuum cleaner can be used to suck out the dust from carcass. This is better than brushing, as the dirt and dust are not so likely to be breathed in. A damp cloth will remove the worst of the dirt from face of woodwork. Examine the back board; if it is badly split it may be well to screw and glue on another piece that goes from top to bottom. Half-inch or $\frac{3}{8}$-in. laminated wood is suitable; it is stiffer for its thickness than a piece of deal, and it is less likely to warp; clamp the new board to the case after gluing, and while screws are being fixed to draw the two together. Look at side boards and repair where needed. If old fillets at top are defective, take them off and replace by new ones, stopping old holes in carcass with plastic wood. Glue and screw on the new fillets, taking care that they go on level.

The hood, perhaps, rests on the moulding and not on fillets, though often the cornice is hollow and does not actually carry the weight of the hood. In any case this moulding will probably need attention. If loose it must be glued and cramped to the sides and front of case. Two cramps may be used at the sides; a double cord can be passed round the carcass to hold the front and the mitred corners. Cut blocks to fit on the corners, make a groove in each to take the cord, and then tighten the latter by twisting a short stick in it at the back, after the fashion of a tourniquet.

Cracks at the mitres should be freed from old glue, and hot glue filled in before cramping up. Panel pins could be used to fasten down moulding at corners and ends, but there is a great likelihood of the moulding being split unless care is taken in boring holes. It can be avoided by drilling moulding for pins with one of the little Archimedean drills used by fretworkers. A

clearance hole just big enough for the shank of pin is required; let drill just enter the wood of carcass and no more. Tap in panel pins and drive home with a punch, taking care the latter does not slip and mar the work. The door, if it wants repairs, can be taken off for the time, until the lower part of the clock has been attended to.

The moulding mitred round case above base needs the same treatment as that higher up. If the veneer of the base has come away and wrinkled it may be just as well to make up a new panel for the front and to take off the old stuff completely. Short of this, we can cut out bad portions, match in new pieces and stain them to suit. Inlaid bandings are usually large and bold on this type of case, and repair should not be too difficult. Certainly if there is much of this ornament or it is badly marred, it is wise to make a new panel. The base may be structurally unsound, apart from the surface ornamentation; in such case it must then be stiffened up by slips or fillets glued and screwed on from inside; gaping joints are to be brought together, clamped and glued, and so on.

The entire front of the base may need replacement; a foundation of good stiff plywood is cut and fitted and then veneered. It is attached to the sides by glue blocks rubbed on.

The cabinet maker has fine and delicate ways of dealing with jobs such as these, but the amateur will have to adopt other, easier, methods. The blocks glued to sides are dead flush with edges, and the front panel fits close to these and covers the edges. The upper and lower ends of sides of base could be strengthened by deal fillets glued and cramped to old wood inside. Lower edge of back board or of the back of base can be served in the same way. If the fillets at sides are end-butted against those at the back, it will be possible to drive in fine oval wire nails from back so that they enter ends of side fillets and thus fasten back of base to sides. This will materially strengthen the bottom of case. To return to our front panel, we can attach it to the blocks on sides by gluing and by fine screws inserted in countersunk holes from front; screws must be long enough to get a firm hold. They will not be very conspicuous in any case; and could be hidden by tiny circular pieces of veneer glued in to countersinks afterwards. Plastic

wood could be used in a simpler method of filling up recesses.

Supposing that the base rested on four shaped corners, and that these were defective, we might substitute for them a simple plinth. This would be made of ⅝-in. by 4-in. oak or mahogany with a suitable moulding above. It is cut out and fitted to base, mitred at corners, and then shaped with a compass saw or coping saw to a

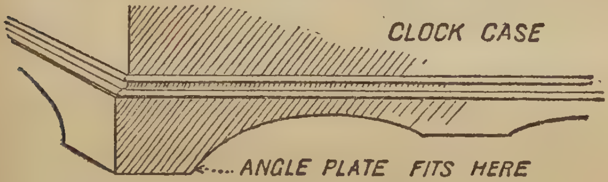


Fig. 7

Angle Plate at corner of Plinth

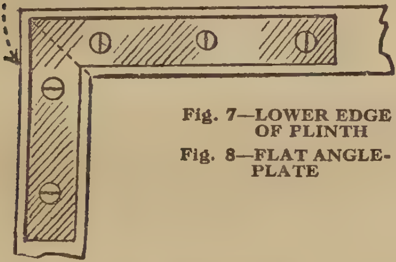


Fig. 7—LOWER EDGE OF PLINTH

Fig. 8—FLAT ANGLE-PLATE

Fig. 8

simple curved outline at lower edge. The plinth overlaps the ends and front far enough to enable it to be screwed through to the carcass, the screws going clean through into the deal fillets at bottom of sides. The side and front of plinth are first tried on, making sure that these make a good mitre; they are unscrewed again, glued, and then fixed permanently in place. The lower edge of plinth corners may be secured by rebating them slightly to take a flat angle-plate, which is then screwed on underneath (*see* Figs. 7 and 8).

The hinges and lock of door next demand attention. The former if crippled may be replaced by similar ones if they are of the ornamental type. Any ironmonger

could obtain them, and the handyman could at the same time order other missing ornaments—such as the gilt brass pinnacle usually to be seen at top of the hood. At the side of the glass door to head of clock are usually two plain or fluted wooden columns which are fixed in gilt "base" and "capital" brasses screwed to the woodwork. These parts might be obtained at the same time as hinges, etc. If ordinary butt hinges are on the door, they are easily substituted by new ones. One often finds the lock missing and the recess that held it badly damaged. Get a new lock and cut away or block out the recess to suit it. A new keyhole may have to be cut. Any blemishes can be concealed here by inlaying a diamond-shaped ivory escutcheon pierced for the keyhole.

Should the old door be badly damaged, a new one can be cut from a sound and seasoned board and the edges rebated. If the top is shaped, the door opening will just as likely have a square head. The rebates are to be worked on sides as usual in such jobs. That at the bottom needs sawing across face and edge with a fine backsaw and the waste wood carefully paring away. At the top, cut a squared rebate to fit door opening, carrying it out to the shaped top edge. Another method of doing this job is to use two thicknesses of board—say $\frac{3}{8}$-in. oak or mahogany inside, and a faced plywood for the outer, shaped, piece. This avoids the need for rebating, since the outer piece is left wider, of course.

The hood may now be taken in hand. As a rule it slides on from the front, though in some clocks it slides upwards. If the glass door sticks it may be eased with a sharp plane or with a flat stick covered with sandpaper. The treatment depends on the amount of material that has to be removed. If the hinges are defective, one or both should be replaced. It is fairly easy to shape them up from thin brass plate. If putty inside glass has cracked or come away in places the rest can be hacked out and the glass puttied in again. When removing old putty, look out for brads or tacks that may be concealed in it. The door is usually a tight fit in its frame and is often held by nothing more than this. If it has become loose a piece of veneer may be glued to the edge where needed to make it tighter. A tiny brass catch

or button should be screwed to the frame to secure the door.

Examine the joints of the hood and carry out any needed repairs in the manner indicated earlier, reinforcing by slips or fillets and making good any broken parts in mouldings, etc. Should the ornamental woodwork at the top have suffered, it is usually possible to glue on pieces shaped to the proper profile or mould. A new spire or ball and the fixings for columns are fitted if needed. If a fluked or twisted column is missing the pair may be replaced by two of a pattern more easily copied.

If there are any defects in moulding or veneer anywhere else in the clock case, make them good; fill holes with plastic wood, leaving surface well up to allow for cleaning off afterwards. Colour any new parts to match the surrounding surface. Thoroughly scrape the face of the case everywhere to remove old polish or varnish, and rub down with sandpaper. Next the wood is treated with a filler and is prepared for french polishing. Instructions for this operation are given in another part of this work.

Finally, look at the seat-board, and if it seems unsatisfactory or is damaged, cut a new one from a piece of oak. The old board will serve as a pattern; the holes or recesses for cords and that for the pendulum must be accurately copied. Bore holes or slots for the hook-bolts that go over pillars. If top edges of sides are not square or are split, fillets should be screwed and glued on inside, taking care they do not foul the weight lines. Lay the seat-board on top, fasten on movement, and try on hood to make sure dial comes in the proper position and central. Also try on pendulum and see that it is in beat when seat-board is level and case is upright. Now take off hood, unfasten movement from seat-board, and nail the latter firmly to top edges of sides. It should not thereafter need to be removed, for the proper way to take off movement is to slacken off the hook bolts until they can be pushed up free of pillars.

We mentioned above that the pendulum was to be set in beat when the movement on new seat-board was tried in the case. In another part of this article the matter has been explained as regards other types, but

here we may add a few remarks. If case is properly constructed, the seat-board should be horizontal when the case is upright. The movement, when fastened down on the board, should have the pendulum cock central and vertical. Try it for the latter with a plumb line. Now, having ascertained that these points are correct, put on pendulum and mark where it hangs, by a line down the centre of the backboard. It should swing as far to one side of this line as to the other, if it is correctly in beat. The ear is a good guide to the beat, and the ticks should be even. Any irregularity can be corrected by bending the crutch sideways a little. Before bending this, insert a thin slip of wood beneath seat-board, if loose, or under one side of plinth, to bring the clock in beat. If raising one side makes irregularity worse, try the opposite side. Having thus brought the clock to a regular tick, remove the wedge so that the clock is again irregular. Then bend the crutch towards the side that was raised by a wedge. This, if done properly, will set the clock again in beat.

Keep the clock case locked if children are about, for the swinging pendulum exerts an irresistible fascination, and the clock will not keep time when the kiddies can gain access to it. A dodge to prevent the hood door being opened by unauthorized persons is to fix to its lower part near the closing stile a projecting hook of flat brass. This goes through the front rail inside hood and is caught and locked by a long wooden button screwed to inside of case-front above lower door, on the left. When the latter is opened the lower end of the button can be reached and it can be twisted to one side to lock or unlock the catch above.

FRENCH POLISHING.—This process imparts a hard-drying spirit glaze to wooden surfaces requiring a better finish than is generally possible with varnishes. It is better able to withstand mild heat, and the underlying grain shows off to better advantage.

The composition of the polish varies according to needs, but most proprietary polishes may be relied upon to produce good results if correctly applied. Manufacturers have their own recipes, but generally spirits of wine, gum copal and gum arabic are incorporated; it does not pay to prepare the polish at home. The

valuable woods seldom need any artificial colouring or staining, but as the value scale is descended this becomes more necessary; only the experience of the amateur can teach him the general rules to follow, both in choice of material and its application to the job in hand.

The polish dries in a few seconds and any attempt to delay this drying is to be avoided. Subsequent coats of polish must be put on in one quick operation and then left alone. The quicker the whole surface to be treated is completed the better, for any delay will loosen or dissolve previous coats, and may ruin the job. The work must be done in a warm room, free from draughts, and the temperature, if possible, be kept even.

Preparing the Surface.—The preparation of wooden surfaces must be well done, and follows after the article has been planed, and rubbed down with coarse glasspaper. The polisher has to swell the grain and cut down such swellings of fibre, and also to fill up the cavities between the fibres. The harder the stopping used the better. Melted shellac and beeswax; common wall plaster, well sifted to remove the lumps, and used like cream; white lead stained to the desired colour; and common whiting, are the most common fillings used, and one or other of them is suitable for most ordinary work. If stained they should be made a little darker than the wood in general appearance.

When the filling is dry the whole surface must be smoothed with glasspaper and care taken to remove all surplus material on the surface; leave the filling only in the grain crevices and the holes, or the areas not so cleaned off will show up badly through the polish and hide the grain.

Making a Rubber.—The rubber with which the polish is applied is made by enfolding clean cotton-wool in a piece of fine, clean linen. The wool is lightly damped with polish and the linen wrapped round and drawn tightly over it to form a pad almost, but not quite, flat on the face. It must be free from wrinkles or folds and contain nothing of a hard nature likely to scratch the work. The loose portions of linen are twisted up and held in the palm by the fingers. This will leave the thumb and first finger free to direct the rubber over the work.

Endeavour to put on as little polish at each effort as

possible. Do not fill the rubber to such an extent that ridges of thick polish remain on the work; the amount of polish should be hardly noticeable. A small jar of good linseed oil can be kept handy and one dab with the finger tip be given to the rubber face at each application of polish, to save any sticking. As the surface becomes covered the pressure of the fingers should be gently increased to force out the diminishing quantity of polish. The initial coats may raise up the grain a little, and the surface must be glasspapered again with the oldest, fine, clean paper available. Used glasspaper should be kept for purposes like this.

Application of Polish.—The motion of applying the polish should be continuous until any one surface is completed; larger rubbers are used for large surfaces in order to retain sufficient polish for the job. Start at one corner and work spiral fashion along the edge, returning along a parallel line from the ends, and finish on the corner diagonally opposite to the starting-point. The circular motion should be kept the same size throughout. When the surface seems bright enough for the purpose it will show some shadows made by the linseed oil; these must be wiped off with a clean new rubber damped with methylated spirits. The final strokes, which should be very light in pressure, are made from end to end in the same direction as the grain.

Spirit Stains.—These can be obtained in the form of crystals which will dissolve in the polish, and are very useful in obtaining rich tints without actually applying the stain directly to the wood. Most of them should be used very sparingly in the polish, as they become more powerful in colour some time after mixing; experiment is advisable before commencing important work.

Glaze, or Spirit Varnish.—The use of glaze is a less troublesome method of brightening up or polishing a large surface, but is not as effective as french polishing; it may give a glassy appearance unless done expertly. Made in shades of brown and also clear, the glaze should never be used without first sizing the surface to stop penetration of the wood. The size must be clean, since no glasspapering must be done on the surface before varnishing.

A camel-hair brush should be used and the glaze

applied quickly. The whole work must be finished before drying sets in, otherwise thickening of the coat takes place, and is difficult to hide. A rubber or two of polish on top will improve the appearance of a "glazed" surface. When two coats of glaze are applied, the first should be as thin as possible and left a day or two to get hard.

After-treatment.—The care of polished or spirit-varnished work is important, owing to the trouble and difficulty in obtaining such finishes in the first place. Furniture polishes mainly composed of wax are excellent, and their occasional use not only brightens the polished surface but protects it from stains, hard knocks and scratches. Polished articles should not be placed close to a fire or anywhere else where they may get very hot.

The handyman should keep his stock of polishing materials in tightly-corked bottles, each properly labelled. Then he will know exactly what each contains when he wants it. A warm place should be chosen as a store, but not near a fire, as the polishes are highly inflammable.

FRETWORK IN WOOD AND METAL.—The modern conception of fretwork is very different from that of a generation ago, when this form of woodworking was indiscriminately applied to every design and style of work imaginable, resulting all too often in the production of articles that had neither beauty, utility nor good taste. To-day, however, fretcutting in wood is chiefly confined, with commendable restraint, to such work as the decoration of furniture and cabinet work—for instance, of wireless cabinets and the open "frets" of loud speakers, for which purpose it is, indeed, indispensable; while fretcutting in metal is responsible for the production of ornamental hinges and lock-plates in a variety of beautiful and elegant patterns.

For work in wood the amateur is recommended to choose a fretsaw of good quality; it will prove cheapest in the long run. A saw with a 14-in. sweep will be capable of taking large work; the top screw should be provided with a lever for automatically stretching the blade to a workable tension, and there should also be a screw in the handle for adjusting purposes. Such a saw will cost about 4/–. If the amateur is likely to do

much fretwork and if his means permit, he is strongly advised to invest in a fret-cutting machine, operated by means of a treadle. A saw of this kind usually has a sweep of 18 in. or more; it cuts much faster and works altogether more steadily than a hand frame, and, if fitted with a tilting table, it can be used for inlaying work. But its greatest virtue, perhaps, is that it leaves both hands free for guiding the wood, thus making it possible to obtain great accuracy in cutting. A treadle saw costs from 25/– to 50/–.

A special cutting-table can be bought for use with a hand frame for a shilling or two, but it is easily made at home out of planed ½-in. stuff. Cut out a piece about 8½ in. by 4½ in. This has a V-cut in one end of it, about 2¼ in. wide at the broad part and extending 3¾ in. into the table, where it ends in a hole bored with a ⅜-in. bit. About 2½ in. from the other end of the board a hole is drilled large enough to admit the upper part of a small iron cramp, by means of which the contrivance is attached to the edge of an ordinary table. A slot must be recessed into the wood in which the top part of the cramp may lie, flush with the surface. The cutting table would be much more stable in action if it were made a little wider and fitted with two cramps, one on either side of the V. Metal tables can be bought, but if the saw blade comes accidentally into contact with one of these, it will be broken, or have its delicate teeth blunted.

Only blades of the best quality should be bought; the difference between the cost of inferior blades and that of blades of the finest kind is practically negligible, and the amateur should never buy the former, even for the roughest kind of work. Fretsaws are sold in ten different grades, but a medium saw—especially No. 2—will be found the most generally useful for wood. The saw must always be fitted in the frame so that the teeth point *downwards*, towards the handle.

A drill will be necessary for boring small holes in the wood for the insertion of the saw blade. The most suitable type is that known as an Archimedean drill, which is operated by means of a sliding bobbin moving up and down a spiral stock. For drilling thin wood the simpler kind will be found suitable, but for piercing

thick wood quickly and accurately a drill fitted with a governor or one with a double thread to the nut is recommended. A simple Archimedean drill, with half a dozen steel arrowhead points, can be obtained for about 1/6.

A number of small files of various shapes and gauges will be needed for cleaning up and finishing rough edges after cutting. Four files will do to start with: round, half-round, flat, and triangular. A sandpaper block and a supply of sandpaper in various grades will also be required. The former can be made at home in the following manner: Get a block of hard wood, such as beech, measuring 3 in. by 2 in. by $1\frac{1}{4}$ in. The bottom face must be perfectly flat and smooth. Across the upper surface cut a groove about $\frac{1}{8}$ in. from each end; the grooves should be about $\frac{1}{4}$ in. in width and depth. A strip of sandpaper cut the same width as the block is stretched tightly over the lower surface and the ends are brought over to the top and kept pressed firmly into the grooves by means of a broad piece of spring steel which, when extended, is somewhat longer than the distance between the grooves. The sandpaper block is chiefly used for removing the remains of the pasted-on paper pattern when the design has been cut out. Damping the paper for this purpose is to be avoided, since it is apt to distort the wood and raise the grain. No. 2 medium sandpaper is used for removing the design, while the work may be finished with No. 1.

Some small brass screws and fine nails will be needed for assembling the various cut-out parts and attaching hinges, etc., as well as a tube of patent glue. A very light hammer will also be found useful, and can be bought for a few pence. The amateur will require a small screwdriver—made by filing the point of an old bradawl to a chisel shape and tempering it by heating to a dull red and plunging in cold water—and a pair of wire-cutting pliers.

Fretwood is sold by the foot in various thicknesses, usually ranging from $\frac{1}{16}$ in. or so; $\frac{3}{16}$ in. is a useful thickness for ordinary work. For overlays $\frac{1}{16}$ in. will be found suitable. All wood for fretwork must be thoroughly seasoned; it must be perfectly flat, without twist in any direction, and must be of a uniform thickness throughout.

Freedom from knots, cracks or burrs is also necessary, and a fine, smooth finish should be looked for. It must be understood that the term "fretwood" is applied to thin wood of a single thickness, and does not include plywood. Whenever the latter is used in fretwork, it should be of the best quality and of the same colour all through. Plywood is useful where extra strength is needed, but it should not be used for the finer kinds of work.

Fretwoods.—Satin walnut is a favourite fretwood, being of a pleasing shade of brown and very easy to saw. It can also be obtained in wide sheets, a virtue which some of the finer and more expensive woods do not possess. Hazel walnut is somewhat similar, but darker and less even in colour. Birch is a light, strong and easily worked wood; it can also be obtained as a plywood. Mahogany is of a handsome, red-brown shade, and is quite easy to work; it can be french-polished. Holly is very hard, durable, close-grained and of a white colour. It is suitable for overlays and also for inlaying. Poplar, another white wood, is soft and lacking in strength, but is useful for linings, backgrounds and veneered work. Oak, either plain or figured, is popular for large work; it has a handsome grain and can be wax- or french-polished. Figured oak can be relied upon not to twist, a quality that is essential in some kinds of work. Sycamore is very close- and even-grained, and makes a good substitute for holly. American whitewood is even-grained and easy to cut, while ebony is heavy, compact and extremely close-grained; it can be cut into complicated patterns without much difficulty. Silverwood is usually sycamore or maple that has been stained an attractive shade of silver-grey.

Although fretwood is sold by the foot, a square foot of stuff will not necessarily measure 12 in. by 12 in. for one side may be longer than another. Therefore, if a particular length is wanted, it should be specified when ordering the wood. Some of the firms who cater for woodworkers make up parcels of odd pieces of fretwood for sale, and to begin with, the amateur would do well to buy one of these, since they often contain nice pieces of stuff at far less than the usual cost of wood bought by the foot.

Fretwood patterns, in endless variety, can be bought in sheets all ready to paste on to the wood. In a good pattern, the little bridges which support the cut-out portions in the finished work are tastefully incorporated in the design and afford sufficient strength without being too conspicuous. Should it be desired to preserve the design, it can be transferred to the surface of the wood by means of carbon paper, using a sharp pencil or marking point. A more accurate method is to add enough turpentine to a thick jelly made from common soap to form a paste on stirring. The face of the design should be moistened with this preparation and a sheet of clean paper laid on top. Pressure should now be applied until the soap film is dry, when it will be found to bear a copy of the design. This method is particularly useful when duplicates of a single pattern have to be cut out. The advanced fretworker would saw two or more thicknesses of wood at one and the same time, but for a while this will be beyond the powers of a beginner.

If it is desired to make a reversed duplicate from a single pattern, so that when the two halves are put together they will form a symmetrical whole, the pattern may be carefully and accurately traced on transparent paper, which is reversed before being pasted up. When tracing designs or making carbon copies, straight lines should be drawn with the aid of a ruler, and circles and their segments described with a pair of compasses.

The design must be pasted down in such a way that its longer dimension runs parallel with the grain of the wood, except in the case of hard and close-grained woods like holly and ebony, in which the direction of the fibres is immaterial. Flour or starch paste should be used, never glue or gum. A serviceable paste can be made as follows: Mix a teaspoonful of white starch into a cream with cold water; it must be thin and quite free from lumps. Add sufficient boiling water to make the starch jellify, at the same time stirring rapidly. It should be allowed to get quite cold before being used, and may be kept indefinitely if a few drops of oil of cloves or carbolic acid are added.

The paste should be evenly and thinly smeared over the back of the design; the latter is then laid upon the wood (the better and smoother side of it, if there is any

choice), and pressed down firmly but gently with the hand so as to force out any wrinkles. Care should be taken that the design is not torn or stretched while this is being done. In pasting large designs there is a risk of tearing and stretching the paper in this way, and in this case the paste may be applied to the wood instead, paper being laid on at once and smoothed down. If any stubborn air bubbles form, they must be pricked with the end of a knife and pressed down flat. To prevent the damp wood from buckling and warping, it should now be laid face downwards on a double sheet of clean blotting paper, covered with a flat board, and have a heavy weight placed on the top, being left until it is quite dry; or it may be placed under light pressure in a hand-press.

When the wood is quite dry, it is ready to be drilled with holes for the insertion of the saw. Clamp it down firmly upon a piece of ½-in. waste wood and drill a hole in every enclosed part of the design that is to be cut out. The holes must be made in the waste part of the design adjacent to the path that the saw is to follow, but on no account should they be right in the saw line itself. Convenient places for drilling are opposite corners and projections, as it is usually best to start the saw at these places. Do not press too heavily upon the drill, and keep it revolving as you withdraw it from the hole, in order to prevent the point from being broken. When all the necessary holes have been drilled, turn the wood over and rub it with glasspaper, in order to remove the rough places left by the breaking through of the drill, which, if not rubbed down, would hinder the free movement of the work upon the cutting-table.

Inserting the Saw-blade.—The lower end of the saw-blade should be clamped in the frame, and the other end must then be inserted through one of the holes in the wood and firmly screwed up. The tension of the saw should next be carefully adjusted, bearing in mind that a saw that is not sufficiently taut will probably snap before it has made many strokes. Experience alone will teach the fretworker how taut he must make his saw for any particular kind of work.

The cutting should be done in short and regular up-and-down strokes, the saw being kept perfectly upright

and following a path that is actually in the waste wood, so that the saw-cut may not take anything from the actual design. The saw must be kept moving constantly, while the work is fed up to it with the left hand, being deftly turned so as to follow curves and negotiate angles without interrupting the cutting. As a general rule, the inside spaces of a design are cut out before the outside is attempted; but this order may be reversed if the bulk of the inside wood is to be removed, as in the case of a thin overlay for a photo frame, since if the inside were first cut the wood that was left might be too weak to allow the outside to be cut afterwards without snapping. When a delicate part is being cut, it is often a help to bring the work nearer to the side of the V in the cutting-table. The sawdust that forms round the part that is being cut must be frequently blown away, so that it may not obscure the design and lead to faulty work. Very thin wood, such as overlays, as well as thin sheets of metal and xylonite, are usually nailed firmly between two thin pieces of waste wood while being sawn.

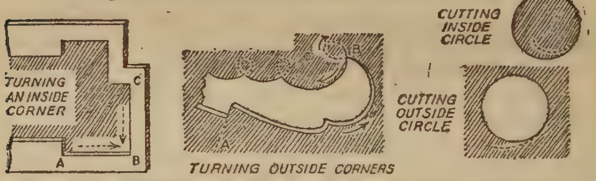
Curves and Angles.—Sharp curves and angles are likely to cause most of the beginner's trouble. The cleanest way of cutting an inside angle is to approach it along each side separately in turn. Another method is, upon reaching the point of the corner, to move the saw up and down without allowing it to cut and at the same time taking care to keep it well in the waste wood. Turn the work gradually until the other line composing the corner is presented squarely to the saw and continue cutting. Thus, in Fig. 1, the corner B can either be approached in two separate operations, following the directions of the arrows from A to B and from C to B; or it can be turned in one continuous cut, without retracting the saw, but merely causing it to "mark time" at B just inside the waste while the work is turned round.

Outside corners may be cut in a similar fashion. An alternative and neat way is that illustrated in Fig. 1; the saw, entering at A and following the direction of the arrows, is carried on into the waste wood when the corner B is reached, so that it describes a complete curve, as is shown by the dotted lines. It is brought out of the waste to face exactly the new direction that it is to follow.

Circles and Ovals.—These and similar curved figures,

whether internal or external, should always be approached from the waste at a tangent or acute angle, so as to make the point of entry as inconspicuous as possible. Fig. 1, which illustrates the correct way to cut an outside and an inside circle, shows how this is done. Remember always to make the angle of approach as acute as possible, so that it goes imperceptibly into the outline of the curve. The tiny ridge that is left when the saw has completed the circle can afterwards be removed with a rat-tail file.

Fig. 1—CUTTING CORNERS AND CIRCLES



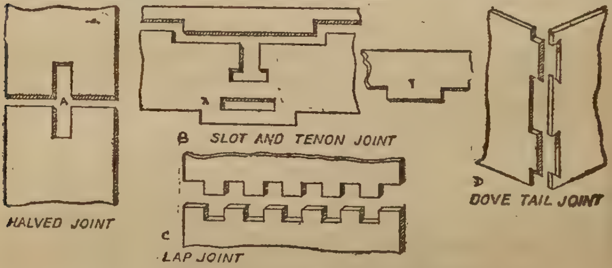


Fig. 2—USEFUL JOINTS IN FRETWORK

All cut-out pieces with well-defined angles, such as triangles, rectangles, hexagons—as well as angular spaces bounded by curves—should be commenced at one of the angles, the cutting proceeding in an anti-clockwise direction. It is as well to examine the design thoroughly before cutting it out. It will be seen that some of the lines that the saw is to follow run parallel with the grain of the wood, while other lines run across it. The latter are weaker lines than those that run with the grain, and, wherever possible, they should be cut away first, thus retaining the utmost support afforded by the waste wood until the very last. The worker must likewise

arrange his cuts so that he avoids leaving a large or heavy piece of waste wood to be supported by a weak and narrow neck, which would incur the risk of breaking part of the design. A "tie" forming part of the design—such, for instance, as assists in joining the internal ornamentation to the surrounding framework—must receive particular care, and the line of the pattern must be closely and exactly followed. If left too thick the tie will present a heavy and ungraceful appearance, while if the saw is carried into it too far, the support which it is intended to give to the adjoining part of the design will be weakened.

Multiple Cutting.—This process—the sawing of several pieces at one time—should not be attempted until the fretworker has gained a complete command over his saw. It will then prove very useful for cutting two or more pieces to the same shape simultaneously. The pieces of wood should be laid one upon another, with their grain running in the same direction and the pattern on the top. They are then to be firmly fastened together with small nails or brads driven through the waste wood all round the margin and at several other points inside as well. The saw must be kept perfectly upright, since the slightest slope to either side will result in making the lower frets of a different size and shape from the upper ones. The margin must be cut off last of all. Multiple cutting is performed with much greater ease with a treadle-saw than by hand.

When all the waste wood has been cut away, the remaining fragments of the pattern are to be removed. This is effectively done by stripping off as much of the paper as possible with the fingers and a sharp penknife, and then removing the rest with the sandpaper block, using medium-grade paper. Always rub the block in the direction of the grain of the wood, never across it, which would be liable to injure the fibres. Also, never be tempted to moisten the paper with the object of loosening it, since this will probably end in warping the thin wood.

Rubbing Down.—The work must next be well smoothed on both front and back with medium sand-paper, and then the edges are to be trued up where necessary by filing. An excessive amount of truing and correction will not be necessary if care has been exercised in the use of the saw; the amateur should bear in mind

that only rarely can careless sawing be compensated for by subsequent filing. Another good rubbing on both sides with fine sandpaper, and the wood is ready for oiling or french polishing; or it can be left plain, if preferred. In sandpapering thin and delicate frets, it is often a good plan to replace temporarily some of the waste wood that has been removed, particularly in the more intricate portions of the design, so as to guard any parts of the work from being caught and wrenched by the sandpaper; a square edge all round can be assured by laying the work in the margin of waste wood that surrounded it and then running the block over the whole.

The further treatment of the wood must depend upon the purpose for which it is intended as well as upon the amateur's judgment and good taste. Some work is best left quite plain, so as to display the grain and natural colour of the wood. If the amateur wishes to try his hand at french polishing, he will find this operation described under the heading FRENCH POLISHING. A very satisfactory finish for some classes of work can be attained by rubbing in raw linseed oil a little at a time and just enough altogether to throw up the grain of the wood, taking care to avoid a shiny or greasy appearance. A wax polish—made by melting together shredded beeswax and turpentine to the consistency of a thick paste—makes a very handsome finish; it should be rubbed in with a piece of old felt, using plenty of "elbow grease."

Fretwork Joints.—Fretwork, which for the most part is not required to stand any great strain, is usually fastened together with glue and small screws and nails. In addition, several joints are commonly employed which are modifications of those used for joining more solid work. They are the half-cut or halved joint; the slot and tenon, a modification of the ordinary mortise and tenon; the lap joint; and the dovetail joint.

The halving joint is used for joining two pieces of wood at a right-angle. Each piece has an open slot, as wide as the thickness of the other piece of wood, extending halfway into the width that is to be joined, as is shown at A, Fig. 2. Each of the two parts can thus be inserted halfway into the other when glued; this method secures a firm right-angle joint.

The slot and tenon joint is illustrated at B; X shows

the slot and Y the tenon which fits into it. The slot must be of the same *width* as the *thickness* of the wood which is to be tenoned into it; apart from this, it requires no explanation. It is a useful joint for attaching an upright piece of wood to a base board or stand.

The lap joint is shown at C. It is employed for fixing two pieces of wood at a right angle along their edges, where there must be no projecting wood; the latter feature is inevitable, of course, in the halved joint and the slot and tenon. A typical example of the lap joint is in the joint of a corner bracket.

The dovetail joint D is employed for joining two pieces of wood that lie in the same plane. It cannot be used for making an angular joint, as in ordinary joinery and cabinet making.

Joints are usually marked in the pattern and are cut out with the fretsaw like the rest of the design. However, tenons and open-sided joints that lie on the edge of the work, such as halved, lap, and dovetail joints, may with advantage be cut out partly with a fine tenon saw, the use of which will ensure a straighter cut. Where possible, joints should be cut and tested by being fitted together before the main part of the design, as it is easier to adjust them—should this be called for—at this early stage than later on.

Before they are cut, the joints should be carefully measured up and tested. The best way of doing this is to draw parallel lines with a rule from one half of the joint to the corresponding half on the paper pattern. In cutting a joint full allowance must be made for the saw "kerf," and it is just as well to make the tongues rather full, the slots a little narrower, and later reduce them to an exact fit with file and glasspaper. Tenons should be made slightly long and afterwards cut down flush with the plane or chisel.

PICTURE-FRAMING.—Making frames for pictures is one of the simplest and at the same time most pleasant forms of woodworking. The amateur—particularly if he is newly furnishing his house—can save himself an appreciable amount of money by framing the pictures, prints and engravings himself and to his own taste. Reference to a trade catalogue will give him an almost endless choice of picture-frame mouldings; but until he

has "got his hand in" by a little practice, he will be wise to restrict his selection to wooden mouldings that are as plain as possible and preferably of some hard wood, such as oak. Gilded mouldings and ornate wooden ones should be avoided, to begin with.

The tools required in picture-framing comprise a dovetail saw, or fine tenon saw; a jack plane; a mitre-box, or mitre-block; a mitre shooting-board; a mitre-cramp; a chisel or two, and a bradawl. The mitre-block is usual for cutting the joints of small narrow mouldings, while the box is employed for large mouldings. A shooting-board is used in planing up the ends of the moulding perfectly true and smooth after they have been mitred. The moulding is laid against the fence of the shooting-board and slightly overhanging the edge, and the plane is passed along on its side, removing a very thin shaving at a time until the wood has been planed down to a smooth, even surface.

Measure the length and breadth of the unframed picture, or its mount, if it is furnished with one, and mark off these measurements—with about $\frac{1}{8}$ in. added to each—inside the rebate of the moulding. Then lay each moulding in turn firmly against the side of the mitre-box or block, and cut the mitre with the tenon saw. Painted, lacquered, enamelled or otherwise specially finished mouldings must be cut through from the face side; and in order to indicate the line for the saw on the face, make a light cut in the mitre-box across the rebated side of the wood and transfer each end of this cut on to the other side by means of lines squared across the edge with the T-square. Then lay the moulding in the mitre-box or block and saw through it from the face side.

When the four sides of the frame have been cut out, each end must be finished off on the shooting-board. For this operation, the plane-iron must be very keen; and as we have already indicated, it must be set fine, so that a very thin shaving can be taken off at a time. The four pieces of the frame should now be fitted together flat upon the bench and be tested for trueness with the square. If any of the pieces are too long, they must be replaced on the shooting-board and further reduced with the plane.

Now comes the process of gluing-up. A special corner-cramp can be obtained for drawing the mitres together and holding them firmly until a nail has been driven in, or the glue has set. The cost of this appliance varies between 2/- and 3/- for the simpler varieties. A single cramp holds but one mitred joint at a time, and the gluing-up process is of necessity more awkward than when a proper picture-framing cramp is used. This latter is a more elaborate form which compresses the four corners of a frame simultaneously, the pressure being exerted usually by a screw in the centre.

In assembling the frame, the faces of the joints are thinly smeared with hot glue, and the four lengths of moulding are put together in the cramp, screwed up tightly and nailed.

If separate corner-cramps are used, two corners are first glued and nailed, and the two resulting L-shaped pieces then joined together at the remaining corners.

The glass for pictures should be as thin as is conveniently possible, and quite free from defects such as streaks and air bubbles. It should be cut with a steel wheel or glazier's diamond to a size slightly smaller than the area of the frame inside the rebate. Clean the glass thoroughly with soap and water or with methylated spirit, lay it in the rebate and then add the gilt slip which surrounds the picture and shows it up to better effect. The slip must be accurately mitred at the corners, the saw being used on the face side of the material. A light smear of glue is all that is necessary to hold the corners together. Sometimes the slips are placed outside the glass, but in this case the gilt is apt to soil rapidly, and it is advisable to place them inside whenever possible.

The backboards for picture-frames are sold at shops where mouldings are stocked. The material can be cut with a sharp penknife or cobbler's knife, guided along a straight-edge. Plywood should be used for large frames, and this can be cut with a tenon saw. The backboard is fastened in with picture-framer's sprigs, driven into the inside edge of the frame all round and pressing fairly tightly against the board itself. The sprigs can be driven in without difficulty if they are pressed flat against the backboard with the thumb and tapped gently with the side of an old chisel.

Finally, to exclude dust and damp, gum a piece of stout brown paper all over the back of the frame; the paper should previously be damped, so that it will be stretched tightly on drying. A pair of screw-eyes for hanging the picture should now be affixed to the back of the side mouldings. To avoid splitting the wood, the screws should not be too big, and holes should previously be bored for them with a bradawl. Moreover, care should be taken that they do not penetrate right through the moulding and appear on the other side, or else cause the gilt or plaster to break away. It should be borne in mind, too, that the further the screw-eyes are placed from the top of the picture, the more the latter will hang away from the wall when the picture is suspended. A suitable point at which to place them, measured from the top, is one-fifth of the height of the picture-frame.

VIOLIN, HOW TO REPAIR.—This article is intended to guide the amateur in the adjustment of violins and in the carrying out of minor repairs. In repairing the violin, the novice must be prepared to exercise much care and patience, as a "near enough" job is quite out of the question—another consideration is that good tools and materials are absolutely indispensable to accomplish even the simplest repairs.

The tools comprise chisels and gouges, violin cramps, a fine tenon saw, fiddle planes, sound-post setters, a set of reamers of different sizes, and a pair of callipers. Sandpaper of different grades, pumice powder, crocus powder and both spirit and oil varnishes also are needed.

The repairs which are most often called for are the fitting of a sound-post or a bridge, the replacing of pegs, or the gluing of a finger-board or of the belly of the fiddle. These parts may become loose through use.

The belly of a violin comes loose more easily than the back, since the glue used for the former is thinner than that utilized for the back. Though these repairs may seem trivial ones, a great deal of care and some experience are necessary to obtain satisfactory results.

Sound-post.—The fitting of a sound-post is one of the most delicate operations; upon its position in the body of the violin depends the quality of tone, and a misplaced sound-post ruins the instrument. It has been called not without reason "l'âme du violon." In the case of a

master violin, when by shock or otherwise the sound-post is displaced, it is advisable to take the instrument to a first-class violin repairer, for an inexperienced person may damage the inner surface of both belly and back by over-pressure or misfitting.

When jarring of the violin is due to the sound-post, this latter can be taken out by pushing it towards the centre of the violin with the aid of the sound-post setter; this tool is introduced through the *f* hole on the G-string side of the instrument. A gentle pull will soon dislodge the sound-post, which can then be taken out by turning the violin face downwards and shaking the instrument until the post may be seen through the widest part of the *f* hole. From here, with the help of the sound-post setter, it can be pulled out. To reset it, the post setter will have to be inserted firmly in the post, the post passed through the *f* hole on the E-string side, and placed in an upright position about ¼ in. behind the right foot of the bridge. Be sure that the two ends of the post are in perfect contact with the inner parts of belly and back and that the grain of the sound-post is set across the grain of the belly.

A rather poor or deep violin will need the sound-post nearer the foot of the bridge. No one can define exactly the position of the post, since it depends on the individual peculiarities of the instrument. If, in playing, the quality of tone is not what was expected, the sound-post may be slightly moved in any direction by tapping the post gently with the post setter through the *f* hole. In this operation, be very careful not to damage the *f* hole. If it is found that the E string is weak, the sound-post may be brought nearer to the *f* hole; if the G string is weak the sound-post may be pushed back towards the centre of the instrument. The ear is the finest test of accurate adjustment.

Bridge.—The bridge may have to be replaced. Its true position is between the two nicks of the *ff* holes, equidistant from each. The left foot of the bridge must stand over the centre of the bass bar. The way to fit a new bridge (for it is very seldom that a new bridge fits exactly) is to place a piece of fine sandpaper over the belly of the fiddle where the bridge has to stand, and to rub the feet of the bridge over the paper. This will

soon wear down the feet to the curvature required. Be very careful during this operation to keep the bridge vertical. In the case of a new bridge, mark with pencil the exact position of the strings. Then, with a very fine round file, make a small nick in the place where the G, D, and A strings will have to stand; the pressure of the E string is enough to make its own mark.

Fitting Pegs.—Pegs, like bridges, require shaping, for it is seldom that a new peg fits the hole perfectly. Insert the new peg in the hole and turn it for some time; take it out and see where, by friction, the surface has brightened. Very fine sandpaper is used to rub out the bright marks. Again insert the peg, turn it, take it out again and see if the fitting is better. Repeat the operation until the whole surface of the peg makes a perfect contact in the hole. In the case of an old peg, which through use is no longer circular in section, the same process is adopted.

Finger-board.—This part of the fiddle is subjected to wear. The pressure of the fingers on the strings makes grooves in the wood, especially if the finger-board is made not of ebony but of white wood stained black. The best finger-boards are those of ebony, which is harder and therefore wears better. The finger-board is removed by the careful application of warmth; this will soften the glue, and the part can then be taken off. Before replacing it by a new one, thoroughly scrape the surfaces of the finger-board and neck with a perfectly flat steel scraper. Glue for the finger-board must be thin—of about the consistency of milk.

In fixing a new ebony finger-board, it is advisable to warm the surface on which the glue is to be applied. The surface of the neck, too, should be warmed. Apply the glue thinly to neck and finger-board, principally at the edges. Bring the surfaces together and apply cramps. Some of the glue will squeeze out, but this can easily be removed with a brush dipped in hot water.

Repairs to Belly or Back.—Should a serious crack be present in the belly or back of the violin, it is imperative to open the instrument. The correct way to do this is to take a blunt table-knife, the thinner the better, and to work it gently between the bottom edge of the belly and the top of the rib, until it goes through, then work

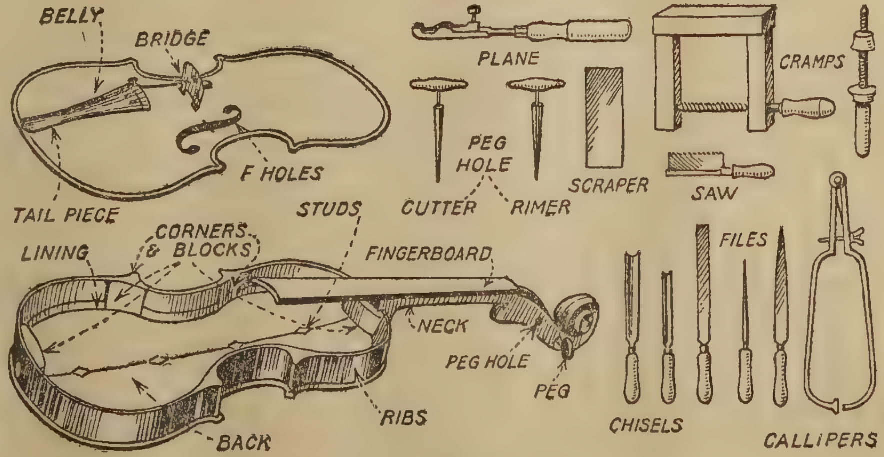
the knife around the edge. Be careful of the corners, as the presence there of a greater surface of glue may easily cause them to break off. When the belly is off blow the dust out.

The method of repair depends on the extent of the crack. By pushing outwards very gently the external surface of the crack can be opened slightly, when glue can be poured in. Then take some studs (*see* diagram) made of hard pine, shaped to the curvature of the surface, and glue them down across the crack, taking care that the fibres of the studs are opposed to the fibres of the fiddle. The fewer the studs and the smaller they are the better will be the repair. The job is cramped up after gluing.

When the crack is only small a little thin glue run into it will cure the damage. In the case of a serious injury the broken part of the belly or back must be cut away entirely and another piece of material put in its place. The cut is made square or oblong, according to the nature of the injury. The hole is bevelled at its edges so as to make it slightly smaller inside than outside. In order to execute a repair that will do credit to the worker, a piece of sycamore, pine or maple should be used. It must be chosen according to the grain and colour of the original broken portion. Cut the piece selected and shape it so as to get a perfect fit to the hole. In shaping it, see that the grain of the new piece coincides as far as possible with the grain of the surface it has to fit.

When every part is absolutely accurate, glue the new piece into place with white glue. When dry, the modelling may take place. Chisels, gauges and sandpaper are used to finish off the patch on the varnish side; just rub off the edge of the varnish, as it will then be more easy to disguise the patch when varnishing the new work.

While the belly is off see that the bass bar, the four corner-blocks, head and tail blocks and the lining are still properly glued. If not, a little glue and the subsequent cramping will remedy the defects. After the inside of the violin has been overhauled the belly may be glued back. First clean off the old glue and get the surfaces of table and ribs as clean as possible. Use thin glue and be careful not to apply too much. In the process of cramping which has to follow, the glue spreads out inside



VIOLIN IN SECTION AND TOOLS NECESSARY FOR REPAIRS

as much as outside. Since glue stops vibration, the less of the adhesive that gets inside the better. Glue also forms a trap for dust and moisture. Any glue that has been pressed out by cramping may be washed off later with a brush and hot water. Do not force the cramps, as all that is wanted is to bring the belly and ribs together. If the belly is merely unstuck from the rib for an inch or two, and is otherwise all in order, simply insert very thin glue with the aid of a thin table knife, and cramp lightly.

Damaged Ribs.—These are repaired in a similar way to damage in the tables. In the case of a portion of a rib being smashed, cut away the full depth and width of the damaged portion. The edges are then bevelled in the same way as for the table, the outer portion being left wider than the inside, a fresh piece of rib—preferably old wood—with the same appearance and grain as the original rib, is cut to fit and glued into place.

Loose Neck.—When the neck of a violin is loose, apply hot water to the joint, taking care that the water does not run along the tables or ribs. By repeating the process the glue will soften sufficiently to permit the neck to be pulled away from the body of the instrument. In no case must force be used. When the neck is off remove the old glue with the brush and hot water, and then dry thoroughly. In order to reset the neck in its proper place, several tests are to be made as follows. Put the neck approximately into its place and lay a straight-edge on the finger-board, projecting well over the belly. The distance between the belly and the straight-edge at the level of the bridge must be $1\frac{3}{8}$ in., or slightly less on some instruments. Another test to determine whether the neck is in line with the body of the instrument is to lay the violin on its edge on some flat surface, such as a pane of glass or a piece of marble, and to measure the distance separating the eye of the scroll from such surface. Repeat the operation by turning the instrument on the other side. Both measurements must be identical.

Having found the correct position for the neck, the next operation is to glue it into the shoulder, by applying hot glue to both surfaces and cramping. Wash off the superfluous glue and verify by testing that the neck has not been displaced in the cramping process.

Colouring and Varnishing.—When necessary repairs have been completed and the new parts have been sand-papered, together with the adjoining old wood, proceed with the staining of the new wood. The colouring materials mainly used are: Saffron, burnt umber, permanganate diluted in water. Gamboge, dragon's blood and liquorice produce a rich colour. It is advisable first to test the mixtures on a piece of the same wood used for the repairs. Experience will teach the worker a great deal as to the quantities to be used. The same applies to varnishing.

The varnishes are of two kinds—spirit varnish and oil varnish. Such controversy has arisen on this subject that it is difficult to advise which of the two kinds to use. The majority of experts are in favour of the oil varnish, as it is more easy to apply. Spirit varnish does not wear so well and is likely to "chip" off. The oil varnish can be applied over any part of the violin except the neck. Spirit varnish should always be applied to this part.

Varnish is needed in such small quantity that it is not worth while for the amateur to prepare his own. It is preferable to go to a reputable violin maker and get the best possible varnish. When buying it, enquire from the maker which colouring matter will dissolve in it, as the varnish will rarely provide the shade that is wanted. Carefully add the different colours needed for matching the tint of the original wood, and bear in mind that each successive coat darkens the appearance of the previous coat. When the tinted varnish is satisfactory as far as the shade is concerned, apply it with a good-quality stiff brush, laying it on as thinly as possible.

After the first coat, hang up the fiddle in a well-aired and warm place. The varnishing operation must be done only in the warmest weather. Each coat will take at least twenty-four hours to dry. Repeat the same operation for the subsequent coats until the colour is properly matched. When dry, very fine pumice powder and oil on a piece of rag will take off the glossy effect of the new varnish, and if needed it may be finished with fine tripoli until the appearance is like that of the adjacent parts. Finally, rub the whole of the violin with a silk handkerchief.

Things for the Metal-Worker to Make and Do

ALUMINIUM.—This metal is rather difficult to solder, but there are various prepared alloys on the market which may be used. Where possible it should be joined by riveting rather than soldering, care being taken not to bruise or otherwise mar the work by a misplaced hammer blow. When buying cooking utensils of aluminium a stout-gauge metal should be insisted on. The handles in cheap goods are often of tinplate, liable to rust. When handles come off take out the rivets carefully and replace with small bolts and nuts. A jagged or enlarged hole may be closed somewhat by judicious blows over an anvil stake. At the worst a piece of aluminium cut to a suitable shape may be placed inside the pot as a washer, the bolts passing through handle, pot and washer. Hold nuts with a spanner and tighten up bolts evenly.

ASBESTOS.—This is heat-insulating material, supplied in the form of cord, "wool," and thin boards, resembling millboard. Asbestos composition in sheets is used for covering framed buildings, such as sheds or garages, and can be had in flat or corrugated forms. Care is necessary in making the holes for nails, and in driving these, for the material is somewhat brittle. As a wall-board the flat sheets are butted, or laid edge to edge, and the joint covered with a wooden fillet. Galvanized clout nails are used to attach the sheets to the framework.

BENT IRON WORK.—This hobby in its simpler forms is an absorbing and inexpensive one for winter evenings. The material used is thin iron strips of varying width. It is bent and shaped with pliers and simple moulds or templates, and the designs are made by combining a few different curves and scrolls of graceful

shape. The elements are held together where they touch by clips formed from the strip itself. This material is a shade under $\frac{1}{32}$ in. in thickness, and is made in widths of $\frac{1}{8}$ in., $\frac{3}{16}$ in., $\frac{1}{4}$ in., $\frac{3}{8}$ in., and $\frac{1}{2}$ in. It is sold in strips and coils.

In making up an article such as a rectangular grille, the framework enclosing the design is formed of wrought-iron, and usually, horizontal and vertical members are of more robust material also. Again, in constructing a wall-bracket, the back, top and spandrel might be of wrought-iron, and thinner strip used for the filling. Bent iron work offers great scope to the man who has an idea for pattern, but absence of this aptitude need not deter anyone from attempting it, for designs can be purchased, or copied from books, while even the simplest combinations can be made up into pleasing and artistic patterns.

Tools.—Shears or "snips" are used to cut the iron strip, and flat-nose and round-nose pliers to manipulate it. A heavier pair of flat pliers—those with side-cutting jaws are useful—and a pair of special closing pliers are needed also. The latter are used to pinch the clips together around the strip, and for similar jobs. A small anvil, with flat and round tapered ends, is fitted into a block for the bench, or into a wooden "leg" like the boot repairer uses for his iron "foot." The latter arrangement allows the work to be done indoors, the "leg" being held between the knees while the operator is seated.

One or two steel punches are needed to make holes in the strip. The latter is placed on a block of hardwood, end uppermost, and the punch struck with a hammer to pierce it. An ordinary "Warrington" hammer, not too large, or an engineer's "cross-pane" can be used. A hand drill and a few twist drills, with a taper reamer, will complete the tool-kit for the beginner. The drill is for making holes in the stouter iron strip.

Assistance in shaping the scrolls and other ornamental elements can be got from one or two simple moulds. Thus from a 4-in. length of $2\frac{1}{2}$-in. diameter wooden curtain pole we can form one such template; and from a pole of smaller diameter another can be made on which to fashion smaller curves. These templates are fastened in a ver-

tical position to a bench-top or to a piece of 9-in. by 1-in. board that can be laid on the table and clamped, or even held in the lap. In the latter case the board should have a short stump fixed on underneath, that can be gripped by the knees. The moulds are screwed to the board from underneath. Countersink the screwheads, and shorter screws will do. A stout nail driven in also from below will stop the mould from twisting. In use, the strip, cut off to a suitable length, is held with both hands and bent around the circular template to the proper shape. The ends of the scrolls are finished with the pliers.

Large curves can be formed gradually section by section, moving the strip along and bending it bit by bit. For a ring we can make the strip entirely enclose the mould, while for a similar shape with back-bent ends we almost close the strip to a ring and bend back the ends to the horizontal at each end. A piece or two of dowel rod will do for shaping yet smaller loops, and the sides of the anvil provide other means. For the body of the C scrolls that are much used in this work we can cut a shape out of 1-in. board, leaving a tongue projecting downwards by which it can be fixed in a vice or screwed permanently to the edge of our bench-board. The frames and other stouter parts of our designs are formed of wrought-iron, $\frac{1}{2}$ in. wide and $\frac{1}{4}$ in. thick, forged and shaped by the blacksmith. Intervening members, such as those that divide up a fire screen into panels, are of $\frac{1}{16}$-in. by $\frac{1}{2}$-in. iron strip.

Fire Screen.—This is a square wrought-iron frame 20 in. by 20 in., with bent iron feet that raise it 4 in. from the floor. The frame is made of $\frac{1}{4}$-in. by $\frac{1}{2}$-in. iron, bent up and welded. The feet are of the same material, and spread out to at least 7-in. span. The $\frac{1}{16}$-in. by $\frac{1}{2}$-in. strip can be bent cold in the vice to rectangular forms, but for any further shaping would need to be heated. A large blow-lamp or a gas flame would provide the necessary heat. The ring that forms the centre and also the members that divide the rectangle into four panels are formed of $\frac{1}{16}$-in. strip. These are drilled and riveted or bolted to the frame and to each other; the rest of the work is held by clips, with the exception of the scrolls at top outside and the feet.

On examining the design, it will be seen that there are only four different curves to be made, these being repeated a number of times. Each panel of the screen is a separate unit, and the symmetrical four-fold repetition forms a pleasing though simple filling for the wrought-iron frame. Having procured the frame, it is marked out for the holes for the top ornament, and those that enable the feet and the four right-angled bars to be riveted to it. These bars are shaped up identically: each commences with a foot that abuts against the frame, is then bent at right-angles, then to a quarter-circle, and then to a right-angle to the first arm, after which a foot is formed again at right-angles.

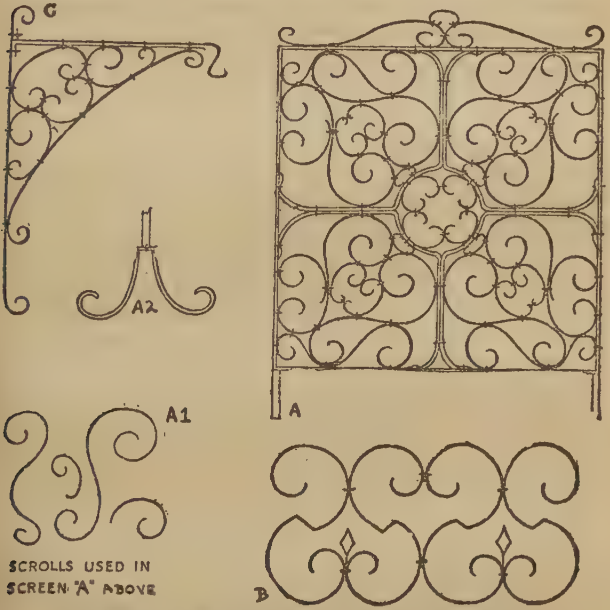
The design given should be copied out full size on a sheet of stiff paper—only one quarter need be drawn—and the iron shaped to fit it. As an aid to forming the quarter-circle a hardwood disk of proper radius could be marked out and sawn and then screwed to the bench. Divide it into four segments by lines at right-angles, and drive into the bench at the correct points two stout nails around which the strip can be bent back after being shaped to the segmental curve. The angles can be trued up on the beak and flat of the anvil. The little upturned curve at the foot can also be shaped on the anvil. It may need to be heated before working. The end of the upturn might be shaped and modelled a little with the hammer to give it a pointed leaf-like shape, but this is optional.

When four of these bars have been formed up they can be tried in the frame, marked and drilled for holes to fasten the feet; and then for the holes that enable the arms of the bars to be fastened together by rivets. The bars are now assembled and fastened to each other and then riveted to the wrought-iron frame. Proceed now with the curves of the filling, making the required number of each shape. The moulds mentioned above can be utilized for the main part, and the scrolls finished with the round-nosed pliers. Any irregularities can be smoothed out with the large pliers.

The curves are fastened to each other or to the frame by clips made from the strip iron. These should be bent down tightly to enclose and bind the members. The scroll work at top of screen and the feet are made o

$\frac{1}{16}$-in. strip. They can be attached by riveting or by means of small screws. In the latter case the holes in frame would have to be tapped. Another method is to use small bolts, with the nuts inside frame.

An alternative filling of a very simple character is illustrated, and it may be said that both this and the



DESIGNS FOR FIRE SCREEN AND LAMP BRACKET

more ambitious design are capable of use in many other ways when a rectangular space is to be filled.

The grille may be backed by a sheet of polished and lacquered copper. The iron work is blacked. Instead of copper a sheet of glass may form the actual screen. In either case the sheet rests in clips made from strip metal, which are fixed around the frame at suitable distances. In the case of the glass backing, see that they are not closed so tight as to nip the glass.

Rosettes and other ornaments in copper or brass are easily cut to shape, and afterwards punched or bent to a hollow shape.

Lamp Bracket.—Illustrated is a handsome wall-bracket for a hanging lamp. A simple lantern in wrought iron might be suspended by a chain and lit by electricity. The bracket is screwed to a wooden plate about 1¾ in. wide, and this latter is fixed by screws to plugs in the wall. The bracket frame—the vertical, top horizontals, and the curved spandrel—is made from $\frac{1}{16}$-in. by ½-in. iron bolted, screwed, or riveted together. The filling is made of thinner strip iron, held together and to the frame by clips. If a stronger bracket was desired, the frame, except the spandrel, could be made of ¼-in. by ½-in. wrought iron, forged to shape and drilled with the necessary holes by the blacksmith.

The scrolls are simple and should present no difficulty; see that they are tightly held by the clips. The bracket is 18 in. high, measured up the vertical, and the hook for the lamp stands out 11 in. A wall-plate of hammered iron would look well with this bracket. The design for the bracket should be copied out full size on paper and all the curves tried by it and arranged upon it to satisfaction before any part is fixed. A coat of dead black colour should be given to all the ironwork after it has been cleaned up.

In cases where everything but a mere rectangle is wanted to be forged by the blacksmith, a complete full-size template or drawing should be given him, on which any holes are shown that are required to be drilled. In the case of a plain rectangular frame, this could be forged first, and then the filling tried in it; after the holes for rivets, bolts, or screws had been indicated by centre-punch marks it could be taken back again for drilling, unless the handyman himself cared to tackle the job.

BLOW-LAMP.—Painters use a blow-lamp for burning off old paint. The flame is followed up with a stripping knife which removes the blistered paint. A caustic solution, however, is often used to-day for this purpose. The metal-worker uses a blow-lamp for soldering or brazing, though a large and powerful lamp is required for the latter operation unless it is a very small job that is to be brazed.

Blow-lamps burn methylated spirit, petrol, or paraffin oil; but the lamps are constructed for one particular fuel that is specified, and no other must be employed. Petrol lamps are convenient in some ways, since no pumping is required to obtain the pressure needed, but for many people this advantage will be outweighed by the drawback of having to keep inflammable spirit like petrol about the place, and by the element of risk that always attaches to the use of petrol-fuelled lamps. In use the lamp is partly filled with petrol, the filling cap tightly screwed down, and the valve closed. Methylated spirit is poured into the cup-like channel at the base of the burner and ignited. Just before this burns out the valve is opened, when the burner should light up. After a spurt or two and a preliminary flare-up the vapour will burn with a blue flame and the lamp is ready for use. Lighting up should be done out of doors, and the lamp will have to be screened from draughts.

Paraffin Lamps.—These are warmed up with a priming of methylated spirit in a similar way, but air must be pumped into the lamp as soon as it is judged to be hot enough, just before the spirit is consumed. The paraffin lamp has a relief valve, which is closed before the spirit is ignited. If when pumping is commenced the lamp spurts out flaming oil the relief valve may be opened momentarily. If this does not stop the trouble the valve must be again opened to put out the flame, the lamp primed afresh and the process repeated. Usually the paraffin blow-lamp starts up readily and needs only an occasional stroke or two with the pump to maintain full pressure.

Spirit Lamps.—Small blow-lamps are sold which burn methylated spirit. One of this sort is an asset to the handyman, and can be used for many small jobs. It is primed with methylated spirit, needs no pumping, and usually has no check valve. It may be found advisable to make and fit a short tubular baffle or air regulator over the flame tube of the spirit lamp. The baffle is made from a copper strip an inch wide, bent round to a tight sliding fit on the flame tube. When starting the lamp the regulator is slid down so as partly to cover the air slots in the base of the tube, and is left there till the lamp is blowing strongly. The best position can be found by

trial. Methylated spirit does not vaporize as readily as petrol, and needs more and longer warming up, but once started such a lamp will burn without trouble until the spirit is exhausted.

Washers of filler caps need replacing occasionally, and new ones can be had at the tool shop. It is important for both safety and efficiency that the filler cap should be a gas-tight fit. The burner nipple should be cleared with a pricker each time the lamp is used. Petrol lamps should be emptied of spirit before being put away. Petrol vapour will otherwise escape from the nipple unless the valve is shut, especially in a warm room.

BOLTS.—Coach bolts are used for bolting together the sections of portable buildings and for any similar constructional jobs. The ⅜-in. size is the one suitable for this purpose, though for very light jobs the ¼-in. may be handy. Washers should be purchased with them. Since these bolts are threaded for only about ¾ in. of their length it is necessary to measure carefully the thickness of the timbers they will pass through, allowing ½ in. extra on the length. The bolt has a mushroom head with a squared portion just beneath it. The square is forced into and grips the wood when the bolt is tapped home and stops it turning. The bolt must be an easy fit in its hole. Careful marking-out is necessary when boring the holes in sections that are to be fixed together in this way. On light jobs it may be possible to place the sections in their proper relation to each other and then bore through *in situ*. Cramps will hold the frames temporarily secure during boring.

Rag bolts can be used for holding down a frame to a concrete floor. The bolt has no head, but instead is expanded and roughened at one end. This is inserted in a hole made in the concrete, and cement is filled in to secure it. As an aid in spacing the bolts a "jig" may be made of a piece of batten, boring holes for the bolts the correct distance apart. This is used for marking-out the bolt holes on the floor, and when the bolts have been cemented in, the jig can be placed over them to hold them upright until the cement has set. Then the jig will be handy for marking the frame that has to fit over bolts.

BRASS.—This metal is used for curtain rods and fittings, for door furniture, and for a variety of othe

purposes in the house. The boilers of toy engines are made of solid-drawn brass tube with pressed brass caps soldered on, and those of more advanced models of similar materials, except that the domed or dished ends are fitted within the barrel and are hard soldered. Brass can be bought in rods of different gauge and section, and in tubes. It is readily soldered, but melts at too low a temperature to be brazed unless a special spelter of low melting-point is used. Brass wire or filings are, in fact, used for the spelter in brazing iron, steel, or copper.

In purchasing the tube for making a toy boiler, the handyman must be warned not to accept the brazed tubing that is obtainable; this has a brazed seam lengthwise, and is therefore unsuitable for the purpose; the solid-drawn tube should be specified. Curtain rods and stair rods are often or usually of brass-coated iron, a material that in the case of curtain rods is not very satisfactory; the brass coating sooner or later becomes corroded away in places and the rest flakes off or peels. Cheap screws may be "brassed" iron instead of solid brass, and the same applies to certain fitments and many similar articles.

When soldering brass, the lacquer—if any—around the joint must be removed with emery paper or the solder will not run. Brass screws should be used in situations where iron ones might rust; and are to be preferred in cabinet work, especially in oak. When driving such screws into the latter timber, a big enough hole should be bored, for when turning the screwdriver against a high resistance the head of the screw may easily be broken off at the slot, or the screw may break at the thread, leaving a troublesome stub to remove, or causing a fresh hole to be bored nearby and the old one to be stopped.

Lacquering Brass.—To save cleaning, brass finger plates and similar articles are lacquered. There are several colourless lacquers to be obtained that merely need applying to the cleaned surface with a brush. Other preparations require the heating of the article after application. In all such operations the brass should be chemically clean and free from grease and moisture before the lacquer is put on. Even finger marks, though invisible, leave a greasy print that stops the lacquer from

"taking." When, therefore, the article to be treated has been cleaned in hot soda water, it must be dried over heat and thereafter handled only with protected hands.

Old lacquer, in the case of a previously lacquered job, must be removed before applying a new coat. Coloured lacquers are to be had as well as the colourless variety. Screws used to affix plates can be held by a piece of thin wire twisted round them and dipped into the lacquer. In driving them a screwdriver of proper size should be used, and care taken that it does not slip. A ratchet screwdriver is useful for such a job, since the head stays in the slot and is less likely to jump out and mar the surface.

Brass is softened by heating, and hardened by hammering. It is used extensively for repoussé work, and the hardening effect of the hammering necessitates that the job be annealed by heating to restore its softness. The same thing happens when brass is being spun in the lathe.

BRAZING.—This is the process of uniting two metal surfaces by means of a molten film of brass or "spelter." Wrought iron and copper are adapted for brazing. Steel can be brazed but not cast iron. Brass itself can be brazed by the use of a special spelter of comparatively low melting-point. Generally it is better to join brass by hard soldering rather than by brazing. Considerable heat is needed for brazing, and the handyman can most conveniently obtain and apply it by using a large and powerful blow-lamp. As pointed out in the article BLOW-LAMP, the paraffin lamp is to be preferred in the hands of the amateur, since the fuel is not so dangerous and is more ready to hand than the highly inflammable spirit used in petrol blow-lamps.

Brazing Pan.—Some form of a brazing hearth is wanted in doing any but the very smallest jobs. In our case it can be a rectangular shallow iron pan full of coke. At the back is a semicircular upright shield against which coke is packed also. Other wing-like pieces can be bent round almost to enclose the back of the hearth. The job to be brazed is assembled and placed on the hearth, supported in some way (by pieces of coke or cubes of asbestos), and the flame played upon it from the open front of the hearth. The coke at the

back and beneath becomes red hot and retains the heat, and generally an iron lid or cap or a sheet of asbestos can be placed on top of the casing, still further to conserve the heat.

Brazing a Model Boiler.—We will take as a specimen job the process of brazing together the parts of a cylindrical boiler for a model engine. These consist of a copper tube 3 in. in diameter and two castings for the dished ends. The first thing to do is thoroughly to clean the parts to be joined, with emery cloth or by filing, as the case requires. The flux we shall use is borax, and the surfaces must be coated with a paste made of borax in water. Then the end casting is forced into the barrel until it occupies the precise position in which it is to be secured. The fixing is done by inserting two brass brazing pins through barrel and end, in small holes drilled for the purpose. These pins should fit tightly.

Light the lamp and let it develop a good hot flame; now warm the job—which rests upright on the brazing pan, partly embedded in the coke—by directing the flame upon it and the surrounding coke or asbestos. Presently the borax flux will fuse and bubble. The spelter, in the form of brass filings and powdered borax, is now to be applied. An iron rod is warmed in the flame, which must be kept directed upon the job, dipped into the spelter, and used to transfer the filings to the seam to be brazed. Spelter will stick to the hot rod and can thus easily be applied to the joint. If the parts are hot enough, the spelter will run and flow round wherever the flux was previously applied. It will be realized how important it is that every portion of the surfaces to be united should have received its coating of borax paste.

When the nearest part of the barrel has been dealt with the boiler must be grasped with tongs and turned round so that the other side of the tube can be seen and properly heated. Spelter might probably run round without this precaution, but it is wise to make quite sure about it. If all looks satisfactory, turn off the lamp and allow the job to cool. Next the other end casting is to be coated with flux, fastened with pins, and brazed in. If the boiler is to have various openings drilled in

it for fittings, these had better be made before the second end is fixed; otherwise there would be no vent for the heated air, etc.; the result would be blow-holes in the spelter round the joint.

After cooling, the barrel is placed in a cleaning bath or pickle of dilute sulphuric acid, which removes the scale produced by the brazing. Some workers dip the brazed job into hot water to cool it; this is not to be recommended in any case, but it is dangerous when the object is a hollow one with only a small opening through which steam can escape. When the red-hot object is dipped or dropped into the water there is a sudden ebullition of very hot steam, which may scald or otherwise harm anyone near. With regard to the mixing of sulphuric acid and water, it is essential to follow certain safety rules. *Never add water to the acid, but always pour in acid, a little at a time, to the water.* Stir the water while doing this.

Spelter.—This is sold in the form of wire and also as filings. Different alloys can be obtained, with higher or lower melting-points, the proportion of brass, zinc and tin being varied for this reason. When using the wire, a few inches are cut off, one end held with tongs and the other heated. The hot end is thrust into borax powder and picks up a bead of the fused material. This end is now pushed into the seam to be brazed, upon which the flame is playing. It melts, and is led round by an iron rod dipped in flux. More spelter and flux are applied in this way, until the job is completed. When making up the granular spelter of filings an equal quantity of powdered borax should be mixed with it.

In conclusion, it may be emphasized that the essentials of good brazing are cleanliness and sufficient heat. It will be found that this latter factor depends much upon retaining heat by proper insulation of the job—this, as we have explained, by packing with asbestos or some other suitable material.

Making a Brazing Pan.—Although a makeshift pan will suffice for an occasional job, the labour of making a proper one is so slight, and the difficulty so little that most workers will desire to tackle this job. A piece of sheet iron 1 ft. 4 in. by 2 ft. 4 in. can be purchased from the ironmonger; some bifurcated rivets will also be

needed. A pair of strong shears or tinman's "snips" are needed for the cutting out, and a mallet to assist in the shaping up.

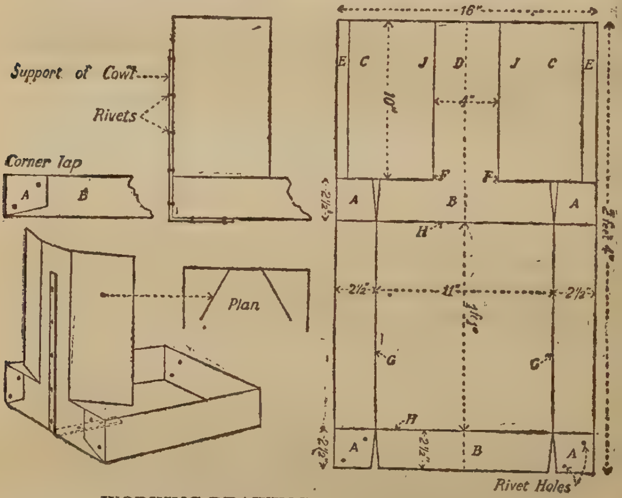
Make sure that the edges are truly rectangular before setting out the bending and cutting lines. Scribe or draw two centre lines at right-angles. Taking the lengthwise one first, set off from it a scribed mark at each side of the centre, 5½ in. from it, at lower edge of the sheet. Then, at a distance along the centre of 1 ft. 6 in. from lower edge set off across the sheet two other marks 5½ in. from centre. Connect these by scribed lines to the 5½ in. marks at lower edge. Now measure up on these verticals 2½ in. and 13 in. from lower edge; at these points scribe lines *across* the sheet at right-angles to verticals. We have thus defined the bending lines for the sides of the pan, which are 2½ in. high; the space bounded by these lines should be 11 in. by 1 ft. 1 in., this being the size of the bottom of the brazing pan.

Above the area now marked out is a piece of sheet iron 10 in. long by the width (1 ft. 4 in.); this, when the pan is formed, stands up as a cowl or shield at the back. It is joined to the back side of the pan in the middle portion, 4 in. wide, and is free for 6 in. at each side. Mark off from the centre line on each side a point 2 in. from line (6 in. from outside longitudinal edge). Similar marks are made at top edge of sheet and connected to lower ones by verticals. Along these lines the cowl is later bent inwards at a suitable angle. Then along the longitudinal edges mark a line ¾ in. from edge to denote where the edge is to be turned over as a reinforcement.

Next the cutting lines may be indicated. It would be well to rule these in pencil to distinguish them from the scribed bending lines. Starting again with the lower edge, 2½ in. from each side, rule up on the scribed vertical a line 2½ in. long to the crosswise bending line. Mark out between the pencil line at the edge of sheet a vertical wedge-shaped piece to be removed with snips (*see* diagram). The pieces A are later bent at right-angles and riveted to the centre pieces B which form the side of pan. At the top of the pan (18 in. from lower edge), measure along 2½ in. from each edge and mark; measure along a farther 3½ in. and mark also:

at the first mark rule a pencil line down along the vertical for a distance of 2½ in., and also indicate the wedge-shaped waste piece to be removed, as was done at lower edge. The line from side to the 6 in. point—the latter indicated by F in diagram—shows where the wing of cowl is cut free from the side of pan to allow the wing to be bent inward.

We may now proceed with the actual cutting out. The first cuts are made inwards to F from outside edge,



WORKING DRAWINGS FOR BRAZING PAN

taking care the cut goes no farther than is intended. In order to give access to the next cut, along the vertical, we must bend the wings upward a trifle. Place sheet on bench or table, and lay on it a square-edged piece of batten even with the scribed bending line J that joins the cut at F. Clamp the batten and sheet to bench. Next grasp the wing piece with both hands and bend it upwards against the sharp lower edge of batten. Only bend it enough for the present to give access for the snips in making the next cut. Both wings are to be bent upwards in this way, and the corner cuts made. A straight

cut and an oblique one will remove the wedge-shaped piece of waste.

Proceed next with the cuts at lower edge of sheet. They are made straight away from lower edge inwards. It is important to make one clean cut from edge to meeting-point, for if two or more "bites" are made at it, unsightly and dangerous splinters of metal will be produced each time a fresh cut is made along the line. The waste piece may be eased out with a pair of pliers if it "hangs" at the meeting-point of the cuts.

In bending up the sides of the pan an 18 in. piece of 2 in. by 2 in., planed up to a sharp edge on all corners, is used as a block. Lay it along the line—marked H on diagram—2½ in. from lower edge of sheet, and clamp to bench. Bend up B, tapping gently with a mallet, until it stands up truly vertical. At the same time bend up the corner pieces A, which will later come *outside* the piece B. Repeat the operation at the top line H, 1 ft. 3½ in. from the lower edge. Here we shall have to bend up the piece B and with it the rest of the sheet, which forms the cowl. The latter, be it noted, is attached to B only by a 4-in. piece in the middle.

Before the top is thus bent up the turnovers at the edges of the wings should have been dealt with by tapping up vertical, and then hammering down over a flat piece of narrow iron strip. The strip is removed and the edge hammered down close. Now the long sides of the pan are to be bent up. The block will have to go inside the pan and therefore must be cut off to a length that will enable it to fit in between the two pieces (B). A fraction less than 13 in. will be the length, which must be found by trial. The ends of the block must be dead square, for they are used in forming the corners of pan. Clamp the block in place at the line G and bend up the side; the piece A comes outside B. With the mallet tap up corner nice and square. The opposite side of pan is served in the same way, and the corners are ready for riveting.

Bifurcated or split rivets are easier for the amateur to deal with than the solid ones. Brass (not "brassed" or copper ones) should be used. A short block of 2 in. by 2 in. is placed against corner (end grain here) and clamped to bench so that the outside corner of pan is

accessible. Punch a small hole at the points marked, driving punch through the two thicknesses of iron and clean into the end of the block. Into the holes thus made drive two rivets, and then gently remove block. Stand up pan on end so that heads of rivets (outside pan) rest on a plate of metal or on an anvil. (The help of another person is useful in this job.) Open ends of rivets slightly with a cold chisel or a screwdriver, and further by laying an old three-corner file in the gap and tapping with a hammer. Then hammer the prongs down flat against the side of pan. All four corners are riveted in this way.

The cowl is to be supported at the back by a vertical strap of $\frac{3}{4}$-in. by $\frac{1}{16}$-in. iron riveted to it, and bent at right-angles beneath pan and fastened here also. In use the pan is filled with coke; the hood, lined with a sheet of asbestos, bent round and fixed with iron or copper clips to the edge of cowl. The latter is bent inwards so that it forms an enclosure round the job being brazed. It can be stiffened by cross pieces of iron riveted over on top if necessary. These would form a support for an iron cap or a sheet of asbestos placed on top to retain the heat.

This job is far less complicated than the description of it; it has been detailed at length because it forms a good example of sheet-metal work, with methods that can be used in forming such things as ashtrays for boilers, zinc trays for the greenhouse, and any similar articles.

COPPER AND ITS USES.—This metal in its untarnished state is a pink colour, but on exposure to the air it soon darkens. It is readily soldered, but is such a good conductor of heat that a good, hot soldering iron is needed and the job itself should be warmed where practicable. Surfaces to be joined must first be tinned with the bit. The flux to be used is "killed" spirits of salts. Copper is brazed without difficulty, and instructions for this job are given in the article on BRAZING.

The metal is sold in rods and tubes, and in sheet form. The latter can be bought in a soft or annealed state and also in a much harder form. It is useful for protecting hearths where a curb or fender does not come close up to the concrete slab or the tiled portion. Another use is in forming a hood or canopy over an arched brick fireplace. The metal lends itself to repoussé decoration.

When drilling thin copper a flat drill is better than a

twist drill; the latter is apt to tear the metal or screw itself through it. Copper after much hammering will be found to have hardened; in fact, strips are treated in this way to give them a springy condition. It can be softened or annealed by heating and subsequent quenching in water. The sheet metal is somewhat troublesome to saw but can be cut with a pair of snips or shears if not too thick.

DRILLS AND DRILLING.—Though a carpenter's brace can be used for occasional jobs of drilling holes in metal, the proper tool for the purpose is a hand drill or breast drill with a geared drive. Big holes (from $\frac{1}{4}$ in. upwards) in hard materials need a bench drill or an engineer's ratchet brace.

The fretworker uses a small Archimedean drill for making holes in thin wood or metal; these usually alternate in direction as the nut is moved up and down the worm, but better ones have a forward motion only, a ratchet action being employed in the nut. It is important to observe that the proper drills are used, as hinted above. While a reversible drill will do for either tool, a forward cutting drill is not suitable for the reciprocating Archimedean. The drill for any such alternating rotary instrument must of course have two cutting edges so that it does work in whichever direction it is turned. The ordinary drill cuts only in a forward or clockwise rotation. Quite small twist drills can be obtained; but the chuck of the usual Archimedean is equipped only for square-shank drills. A much larger drill stock of this sort is sold for general metal work; but we think the handyman would find a hand drill much more useful and convenient. The long stock of the Archimedean drill is somewhat of a nuisance in drilling fine holes.

Hand drills are obtainable in various qualities; owing to the demand in recent years for wireless construction, these tools have been made "down to a price" with, in many cases, poorer and poorer workmanship. Spend five shillings on a reliable one and you will not regret it. Twist drills, too, are sold at ridiculously low prices; for soft metal the cheaper ones are not too bad, though occasionally one comes on a drill that loses its edge in a very short time. When hard metal has to be dealt with the worker should buy only good-class drills of reputable

brand. From $\frac{1}{16}$-in. to $\frac{3}{16}$-in. is the usual capacity of the chuck in a hand drill; above that one must use a breast drill or a ratchet brace. If the question arises, it may be wiser to "go the whole hog," and buy a bench drilling machine rather than a breast drill. Most of the home mechanic's jobs can be taken to the bench, and a large-capacity portable drill is therefore not so necessary.

Both breast drills and bench drilling machines are now sold with enclosed gears running in an oil bath. The bench drill has an automatic feed. By all means purchase one of these machines, rather than the older pattern; it may cost a trifle more but is well worth it. The amateur, especially, needs the most efficient tools he can afford, and in metal working operations even more than in woodwork, good tools save a vast amount of labour and facilitate good work. In conjunction with the bench drill one can use a special vice that fits on the base plate to hold the work being bored—a great help. Time and again the worker needs a "third hand" in such work, and the vice serves in this capacity. In default, the work must be held down by cramps, a poor makeshift—not readily adjusted and taking some time to release and secure again.

Sets of twist drills are sold in cylindrical wooden boxes, and this is a convenient way of keeping them. Drill stands are sometimes recommended, but while these are quite all right for a lock-up workroom indoors, it is not advisable to leave drills out on bench or shelves, exposed to a damp atmosphere, during autumn or winter. Moreover, unless the home mechanic has a workshop all his own, that he can place "out of bounds" to youngsters, it is better to put away all such small and expensive tools as drills. A good way of keeping the larger ones, as well as reamers, taps, broaches and punches, is to use shallow tin cigarette boxes which will take a single row. There they can be seen and got at easily, while a few drops of lubricating oil will prevent rust.

The wooden cylindrical boxes should be secured by a panel pin put through a hole bored through cap and shoulder to stop the cap falling off. Boxes can be stood upright in a long narrow biscuit tin that the grocer will let one have for a few pence, the tin is useful for other metal-working tools that fit in lengthwise. Unless tools

are handy and accessible one might just as well be without them, and the best way to secure this desirable end is to put them in small containers a few together, and the small boxes in one or two larger ones.

Drilling Metal.—Since the home mechanic may have to employ the carpenter's brace for some of his jobs we will tell him how to use this for the purpose. A ratchet brace is best, but not indispensable. Twist drills with square taper shanks are made especially for use with the brace; they are a little more costly than the ordinary twist drills, but for a special job it is cheaper to get one or two than to buy a hand drill. V-pointed flat drills for the brace can be bought in sets or singly; but, except for counter-sinking, these are not very useful and are much slower than the twist drill. Having marked out the work, the holes are started with a centre punch. This is placed on each mark and struck a smart blow with the hammer, so that it indents the metal and provides a pivot for the drill. Now place the drill in the punch mark and rotate it steadily at a suitable speed.

The smaller the drill the more quickly it may be turned. The metal should come away in a shaving that works up along the spiral fluting of the drill. Hold the drill well up to its work by steady pressure on the knob of the brace. When the drill has progressed far enough through the metal to mark the opposite face of the work, turn over the job and carefully drill from the reverse side; in drilling a small hole the latter can be opened out on the reverse side with a taper reamer or a broach. An attempt to take the drill clean through from the face side will most likely result in it sticking and breaking off.

A little oil or soapy water can be used to lubricate wrought iron or steel when being drilled. The softer metals and cast iron require no lubricant. For drilling thin copper or brass a flat drill or one with vertical and not spiral flutes is preferable to a twist drill, as the latter may tear the work. For occasional use of a small round-shank drill in a carpenter's brace a dodge is to put the drill into a small chuck with a roughened shank, and then to insert this chuck into the jaws of the brace chuck. When counter-sinking iron with a carpenter's brace use a large enough V-pointed flat drill bit.

The hand drill, as we said above, is far more con-

venient than a brace or an Archimedean drill stock. It must be held perfectly upright and not allowed to wobble while the wheel is turned. Lubricate the bearings and the spring jaws of chuck; also put a little oil on the screwed end that enters the back of chuck. When very small drills are to be used and it is desired to employ the hand drill, insert the fine drill into a small hand chuck and the latter into the drill-chuck. Suitable chucks can be bought for sixpence or ninepence, and they are useful for other purposes as well, doing duty as a pin vice, for instance, or a broach holder. It goes without saying that when using a very fine drill in this manner we must support the weight of the hand drill and avoid any undue pressure on the point.

The watch repairer occasionally employs drill bits as fine as the finest needles. These are rotated in a little device that is clamped in the bench vice. The drill stock itself runs in bearings on a U-shaped brass mount, with a projecting tail that is gripped by the vice. On the stock is fixed a pulley, and a bow is used to impart rotary motion to this. The job to be drilled is marked and then brought up against the point of the drill with one hand, the other meanwhile operating the bow.

When a hole is to be tapped to take a screw, the size must be properly proportioned to that of the screw which is to be used. It is not enough merely to make a somewhat smaller hole by guesswork and then to force the tap into it. On the other hand if the hole is too large, insufficient metal will be left for the thread. The following table gives the tapping and clearing sizes, and specifies the number of the standard twist drill that should be used in each case, for the more usual sizes of British Association (B.A.) screws. The number of threads per inch is also given. *See also* the article on SCREW-CUTTING.

Screw No.	Threads per inch	Tapping Drill No.	Clearing Drill No.
1	28·2	17	4
2	31·4	24	13
3	34·8	29	20
4	38·5	32	27
6	47·9	43	35
7	52·9	46	40
8	59·1	50	44
9	65·1	53	48
10	72·7	54	51
12	90·7	62	55
14	110	70	61

FILES AND RASPS.—The average amateur's idea of filing a metal surface is pushing the file to and fro across it. When one points out that it is no more reasonable to use downward pressure on a file, in drawing the tool back, than it would be in the case of a saw, some surprise is occasioned. Yet both file and saw are cutting tools, working in an identical manner through downwardly projecting teeth. In the saw the cutting edges are made by cutting away intervening metal; in the file the teeth are formed by raising portions of a surface by the use of a chisel.

Knowing this much about the file, the worker will use it with more circumspection. If a flat surface is to be reduced or smoothed, the work should be fixed in a vice or otherwise rendered immovable. Take an 8-in. or 10-in. flat file of the sort known as "second cut" and rest it on the work, the left hand holding and guiding at the point. Press downward, and thrust the tool forward by pressure at the handle. The downward pressure is to be exerted at the part of the tool that for the moment is traversing the work, and hence must be transferred gradually from the left hand to the right. Too great pressure either at the point or the heel would result in the production of a rounded surface. On the return stroke no pressure at all is needed, and when practice has brought some measure of proficiency, the file can be lifted entirely from the job as it is drawn back; meanwhile it may be allowed to slide back without pressure.

A quarter of an hour's practice at the vice will accustom the worker to the use of the file. Though more often used by him in cleaning-up operations, it is of value in forming slots or grooves and in other occasional jobs of the sort. If the handyman is inclined to metal-working, the following would be a good selection of files: one 10-in. three-square file, bastard cut; one 8-in. three-square second cut; one 8-in. half-round, second cut file; a similar file in smooth cut; one flat parallel file each in 8-in. or 10-in. size, bastard, second cut and smooth cut.

For general use on odd jobs, a 10-in. three-square in bastard cut, an 8-in. three-square in second cut, a half-round of the same length in second cut, and a flat parallel

VARIOUS FILES

8-in. file in second cut are recommended. Of course they need not be purchased till there is a call for them. Handles can be got for twopence or so each, and the file should not be used without one.

Saw-sharpening files, apart from their use for this purpose, are handy to the home mechanic in many ways. Even when clogged and "spent," the fine steel of which files are made renders them valuable for forging into small tools such as punches or cold chisels or screw-drivers. Here we will say that a file should be relegated to another use—such as cleaning up soldered work—when it becomes dulled. Use only clean, sharp files, and discard them when they no longer act efficiently. Probably from a misunderstanding of the principle upon which it works, many novices seem to think that a file never wears out. After using a three-square or a flat file on heavy duty, it is a good plan to mark with a piece of chalk the face that has been used, so that this side can be reserved in future for "cleaning-up" jobs and the unused surface for tasks of more importance.

Files used in key cutting are described in the article on that subject, but the warding file is a handy one that every amateur should keep among his metal-cutting tools. It has a flat, thin blade, and is cut on the edge or edges as well as on the flat, so that it is useful for making slots in soft metal. Swiss files are largely used by watchmakers, and come to this country in a bewildering assortment of shapes and sections—bewildering, that is, to the novice. They are extremely hard and somewhat brittle in consequence; a small flat file in a fine cut is useful for such things as sharpening an auger-bit or a centre-bit.

Rasps.—These are coarsely-cut files for use on wood. A flat and a half-round rasp are useful in a carpentry or cabinet-making tool kit. A proper cabinet rasp is half-round in section, being used for finishing shaped and curved work. The carver uses a double-ended rasp known as a riffler. It has a plain shank and two upwardly bent cutting portions that point in opposite directions. A similar tool with finer cut is used by metal-workers. The boot repairer uses a coarse flat rasp with sometimes a finer cut on one side and a rougher surface on the other. One pattern is double-ended as well as

double-sided; another may have a rounded convex surface on one face and a flat on the other. Cheap leather rasps, that are made of soft metal and are therefore practically useless, are often offered for sale.

HINGES.—The hinge used commonly for doors is the butt. Those used to hang a $1\frac{3}{4}$-in. door should be 4 in. long, with the plates $1\frac{1}{8}$ in. wide, and be attached with four screws. The plates are sunk in the edge of door and door jamb respectively and the knuckle of the hinge should protrude inwards from the face of the stile and jamb.

When it is necessary to take down a door it should first be wedged at the foot; then the screws that hold the plates to jamb are withdrawn from top and bottom alternately and the door lifted out. In replacing it a similar procedure is necessary, wedges being inserted until the door is raised enough to bring the hinge level with the recess in jamb.

When a door is required to lift in order to clear a thick carpet, rising butts can be fitted in place of ordinary hinges. The adjacent edges of the loops are cut in a spiral so that when the door is opened its plate rides along a spiral inclined plane formed in the jamb plate and so is lifted above the carpet. When the door is shut it drops down gradually to the normal level. When it is desired to be able to take away and replace a gate at will—as, for example, in a gate to exclude young children from a staircase, lift-off butts may be fitted. The jamb plate of the hinge has fixed in its loop a taper-pointed pin. The plate that is fixed to the gate or door has merely a loop, which is dropped over the pin in the other plate. The length of the pin and its shape facilitate the connecting of the two parts.

Back-flap hinges are used for lids of boxes or chests, and are attached in the same way as butts, taking care that the knuckle projects beyond the face of the edge of lid and the back face of the box.

T-hinges or cross garnets are used for ledged and braced doors. They are screwed to the face of the work, and should come over a ledge or a batten of the door. Such hinges should be of ample strength. Those for gates and other similar jobs ought to be stout wrought-iron ones, not the light japanned things commonly to be

seen in stores. In fixing them rustless screws are to be preferred—either galvanized iron screws or brass ones of suitable length and stoutness. Ordinary iron screws will become rusted and loosened in time. Entrance gates and other large gates or the doors of a garage are provided with strong strap hinges, the straps being bolted to the framework or to the rails and stile.

IRON: ITS VARIOUS FORMS.—The householder will be familiar with cast-iron in the form of stove parts, and the components of such domestic machines as mangles. He may have had brought home to him one characteristic of this metal—its tendency to crack and break under a shock or jar. Cast-iron may not be hammered, and cannot therefore be forged. Wrought-iron is obtainable in rods and bars and in various other sections (L, T, for example). It is ductile and malleable, and when heated can be forged or shaped and manipulated in a number of ways.

Steel is a form of iron that differs chemically from those above mentioned in possessing a smaller percentage of carbon; it is generally alloyed by the admixture of other metals to secure special properties of hardness, etc. Steel can be forged and shaped under heat, and has the property of taking and retaining a "temper," or degree of hardness, imparted to it. Tool-steel is sold in rods of various sections ready for forming into chisels, punches, or tools for turning metal.

Sheet-iron is useful for bottoming ash-pans, making trays—its use is described under BRAZING—and for similar purposes. Gauge 24 weighs nearly a pound to the square foot, and gauge 20 a pound and a quarter. Tinplate is a sheet-iron which has been given a coating of tin.

Corrugated Iron.—This material is used for covering the roofs or walls of outbuildings, or for forming fences and enclosures.

It is made in various thicknesses or gauges, from 16 to 26 B.W.G., and sheets measure 2 ft. 3 in., 2 ft. 6 in., or 2 ft. 9 in. wide. The stock lengths are 4 ft. to 8 ft., though not all gauges are made in these dimensions. A hundred square feet of gauge 16 corrugated—the stoutest—would weigh approximately 385 lb., whereas a similar area of gauge 24 would weigh only 150 lb.

These weights include the necessary lap of the sheets at their edges.

Gauge 24 is the lightest one the home mechanic will employ for general use; while for a strong and lasting roofing job he might specify 22 gauge. Those heavier still are not likely to be required. Corrugated iron is fixed to purlins, or to studs of a wall, by galvanized nails driven through the tops of the corrugations. If inserted through the trough of the corrugation, rain and other moisture would leak through. A washer is placed on the nail before it is driven. Holes for the nails can be made with a punch, or they may be driven through without. The purlins of a roof ought to be no more than 6 ft. apart when this material is used as a covering. On a span roof the meeting of the sheets at the ridge board is covered with a galvanized capping.

Sheets of corrugated iron are overlapped at least 3 in. wherever joints are made. The size of the building to be covered with this material ought to be planned so as to use one or other of the stock sizes. An inquiry can be made of the local builders' merchant about this point, and the dimensions arranged or adjusted accordingly. If it is necessary to cut the iron across the corrugations, it can be done with a special cold chisel shaped to a semicircular or fan-like edge that will fit into the troughs. A block or thick sheet of lead is placed beneath the portion of the iron to be cut. This job is best avoided if possible.

LATHE FOR METAL-TURNING.—The lathe has been aptly described as "the king of tools," and there is certainly no other mechanical tool so useful or which possesses the same wide facilities for giving pleasure to its owner. It is a tool, however, which requires skill to operate and presents many difficulties to the amateur. But it is not beyond the powers of anyone of average intelligence to master the elementary principles of metal- and wood-turning, and once the groundwork has been truly laid, patience and perseverance will produce the skilled worker.

Probably the chief reason why metal- and wood-turning have not achieved the popularity of, say, fret-work, as a hobby, is because of the somewhat heavy initial cost. Until fairly recently the cost of a lathe was

almost prohibitive to the average man with a hobby, but it is now possible to buy a really efficient machine, suitable for the beginner, complete with tools and accessories, and the means to drive it, for under £3. It is a simple lathe of this type, operated by means of a treadle, that is described hereafter, with its method of use.

The chief use of a lathe is to shape wood, metal, or other "turnable" materials into cylindrical or circular form. The material is fixed in the lathe, by means which will be described later, and is made to revolve by a cord

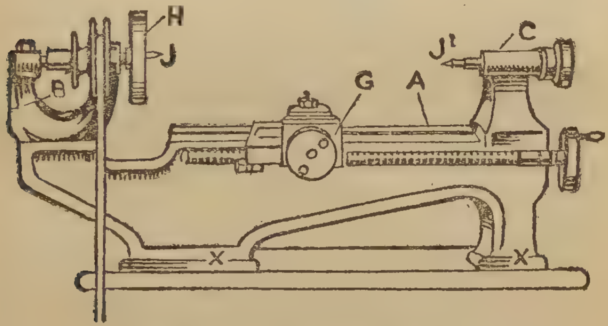


Fig. 1—METAL-TURNING LATHE

or belt passing over a pulley. As the material revolves it is shaped into the form required by applying a suitable cutting tool to its surface.

Fig. 1 gives a general idea of the appearance of a lathe mounted on a suitable bench complete with treadle gear and drive. It is what is called a plain lathe; that is, it possesses no back-gearing and no screw-cutting device. It is suitable only for turning out small work and therefore requires no back-gearing, which is necessary for heavy work. Screws for such small work as will be handled can easily be cut in the metal by means of taps and dies.

The lathe comprises a headstock (B) and a tailstock (C)—sometimes called a loose headstock and sometimes a poppet-head—mounted on a bed (A) which is fixed to a bench. It is driven by means of the driving-belt

passed over a cone pulley and a flywheel, the latter being set in motion by the foot pressing on the treadle.

The bed is made of cast iron and has a slot running lengthwise down the middle. The upper surface, the outer edges of the bed, and the inner edges of the slot are planed and scraped to present an absolutely true surface so that the tailstock can be moved backwards and forwards along the bed. The bed, it will be noticed, has two feet (x) and (x^1) which should be bolted to the top of the bench. It is essential that the lathe should be fixed rigidly to the bench.

The fast or fixed headstock, which in this model is made in one piece with the bed and feet of the lathe, is the most important part, since it carries the revolving spindle, or mandrel, which rotates the work to be turned.

The mandrel runs in bearings and is driven by the belt running on the cone pulley. The nose of the mandrel is screwed to carry a face-plate or chuck. In the model we are dealing with the mandrel has a hole bored through its entire length, through which a long rod may be inserted and held firmly in a chuck, thus enabling the operator to turn up a piece of work that is too small in diameter to hold between the centres. At the nose end of the mandrel the hole is bored to Morse taper and into this fits the live centre, the purpose of which will be explained later.

Fixed to the mandrel and turning with it is the cone pulley. This particular lathe can be run at two speeds, the pulley having two grooves in it. When it is desired that the lathe shall run at the higher speed, the belt is placed on the smaller diameter of the cone pulley and on the larger of the treadle gear. For the slower speed the belt is placed on the larger cone pulley and the smaller treadle gear pulley. For cutting wood, brass and gun-metal the higher speed is used; and for cast iron, steel and wrought iron the lower speed.

The tailstock carries the back centre, and is moved backwards and forwards along the bed to accommodate the length of the material required to be turned. Once the tailstock is in the required position it is locked there by means of a bolt and nut underneath the bed.

The live centre and the back centre hold the material

to be turned, the former being fitted into the tapered hole of the mandrel of the headstock and the latter into the spindle of the tail-stock. Because the work revolves on the back centre, which remains stationary, it is necessary that the centre should be hardened and tempered and a drop or two of oil added to it when the work is placed in the lathe, otherwise it would wear away.

Before passing on to the details of the tool-holder, that is, the slide-rest, it will be as well to explain how the work is held in the lathe between the centres. We will assume that we wish to turn a plain steel or brass spindle.

FIG. 2—CENTRE MARKING WITH ODD-LEG CALLIPERS

The first thing to be done with the spindle is to make tiny holes in the centre of each end. Each end of the bar should first be filed square. The bar should then be placed in a vice with one end upwards and the surface chalked over. With a pair of "odd-leg" callipers four arcs should be scribed on the chalk, thus giving the location of the centre of the rod. With a centre-punch and a hammer the centres are made. Only a light blow is needed and the punch must be held upright and rigid. The other end of the bar is treated in the same way. Fig. 2 shows the method of marking the rod with the aid of the "odd-leg" callipers. Fig. 3 is a typical centre-punch. The bar is now ready to be placed between the centres of the lathe. Once in the lathe the bar should be spun round with the left hand. If the bar appears to run true at the ends but wobbles in the middle, it indicates that the bar is bent. By placing a piece of chalk close to the spinning bar, the side which swings over farthest will be marked with the chalk. The bar should then be taken out of the lathe and straightened by lightly hitting the chalk-marked side with a hammer. If the centres are slightly out then, they should be drawn over by inserting the centre-punch again and tapping the centre-punch over towards the chalk-marked side.

Assuming that the spindle is now centred correctly, a "carrier" should be placed over the end near the head-stock and screwed down tightly, preferably with a piece of rough emery paper between the spindle and the screw of the carrier. This is to prevent the carrier slipping. In one of the bolt holes of the face-plate insert a driving-pin and fix it firmly to the face-plate, near enough to

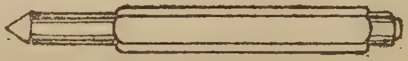


Fig. 3—CENTRE PUNCH

the centre for it to catch the tail of the carrier when it revolves. Fig. 4 shows a spindle with carrier-drive from the face-plate. When the mandrel is set revolving by means of the treadle gear the spindle also will revolve. We will return to the subject of drives later on, this preliminary description being given to enable the home mechanic to get a bird's-eye view of the principle on which a lathe works.

Slide-rest.—Having learned the manner in which a lathe works, we may go on to discover the means em-

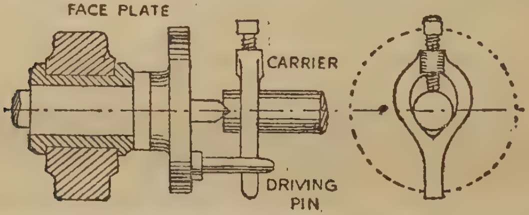


Fig. 4—SPINDLE WITH CARRIER FROM THE FACE PLATE

ployed to deal with the work revolving between the centres. This brings us to the slide-rest, which is primarily a tool-holder. Some cheap lathes are not fitted with a slide rest, but have instead what is termed a tool-rest. A tool-rest is for hand-turning only, that is, all the tools have to be held in the hands. There are many arguments put forward in favour of hand-turning, but none which is really convincing. Since a lathe with a slide-rest can be obtained for practically the same cost

as a tool-rest model, there seems no object in buying the one with the more limited facilities and greater handicaps.

The slide-rest of the lathe we are describing is made in two sections. The lower portion, called the "saddle," fits the bed of the lathe and is moved along it by means of a square-thread screw operated by a handle at the right-hand end of the bed. The top half of the slide-rest, called the "cross-slide," moves across the width of the bed, being actuated by means of a handle on the slide itself. Fixed to the top of the slide is the tool-post, a form of clamp in which the cutting tool is inserted and held rigid.

With the cutting tool fixed in position, we now turn the handle operating the saddle, in order to bring it to the extreme right of the spindle which is now revolving between the centres. Then with the left hand we turn the handle operating the cross-slide until the tool is in a position to take a light cut on the material. To make the cut we rotate the saddle handle, and as the tool moves from right to left it meets the spindle and cuts away a portion. By moving the handle steadily towards the left, the material is cut away, leaving a smooth, even surface behind. That, put simply, is the cycle of operations necessary to working a lathe.

Tools.—We now come to the subject of metal-turning tools. It is a highly important question, because good work cannot be produced on a lathe unless the tools are of the correct shape. Properly applied to the work, a correctly-shaped tool will cut cleanly and leave behind it a smooth, even surface. A blunt or badly-shaped tool will tear away the metal and leave behind it a rough, uneven surface. Three points should be kept in mind:

1. The cutting angle must be keen, so that the work peels off easily;

2. The tool must be strong enough to stand the cut without breaking off;

3. The tool must be so made that no other portion but the cutting edge rubs against the material being turned.

These points will be made clear in the description of the tools and in the illustrations. The tools mentioned are used for cutting cast iron, wrought iron, and steel. They are not by any means all the tools used in turning,

but the amateur turner will find them sufficient for most of the jobs he wishes to undertake.

To take a cut across the front of a piece of material the front tool is used. It is made out of a straight bar of

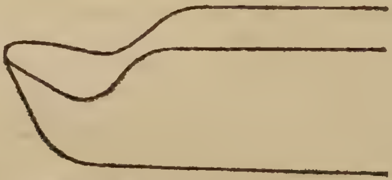


Fig. 5—FRONT TOOL FOR IRON OR STEEL

tool-steel and is shaped as shown in Fig. 5. The swan-necked tool is another form of front tool, and has distinct advantages over the one illustrated, in that it is not weakened by being ground down.

Left-hand and right-hand knife-edge tools (Figs. 6 and

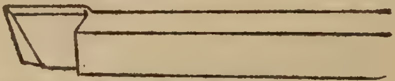


Fig. 6—RIGHT-HAND KNIFE TOOL FOR IRON OR STEEL

7), are so shaped that they can be used to get into the corners of shoulders and to face them up. They are also used to face up the ends of spindles and the shoulders themselves.

The parting tool (Fig. 8) is indispensable to the

Fig. 7—LEFT-HAND KNIFE TOOL FOR IRON OR STEEL

amateur, and can very well take the place of the knife tools for some operations. It is used chiefly for squaring out the corners of grooves and shoulders and for cutting, or parting, two pieces of material which for convenience have been turned up together.

Tools used for cutting cast iron, steel, wrought iron and wood require sharper edges than those used for brass and gun-metal, or bronze. A front tool should be ground away from the cutting point at about 5° and there should be a top-rake of about the same amount. To increase the angle of clearance and the amount of

Fig. 8—PARTING TOOL FOR STEEL OR IRON

rake beyond this, merely weakens the tool without adding any appreciable cutting power.

Before passing on to the tools used for cutting softer metals it will be as well to give some instructions on the setting of the tool in relation to the work between the centres. The cutting point of the tool should be exactly on a level with the line of the centres, as shown in Fig. 9. If the tool is set above this level the work will rub against the tool at a point below the cutting edge. On the other hand, if it is set too low there will be a tendency for the tool to lift the work out of the centres. Should this happen, damage may be caused to the tool, the work in the centres, the centres themselves, and the slide-rest.

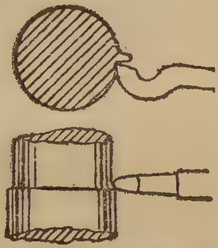


Fig. 9—TURNING

It should be noted that as tools are worn away and ground up again, the cutting point, or edge, is brought below the level of the centres. To remedy this it will be necessary to pack the tool up to the correct height with pieces of strip iron. It is always a wise proceeding to insert between the tool-holder and the tool, and between the packing and the tool, a strip of emery cloth, which prevents any tendency of the tool to slip.

Tools used for cutting brass and gun-metal are much

the same as those used for the harder materials mentioned above, except that they do not require any rake, or need very little. A front tool for brass work (Fig. 10) is narrower than the front tool used for iron and steel, and requires no rake at all. It is brought to a sharper point as a rule, and when turning a shoulder it leaves very little in the corners to be squared out.

A knife-edge tool is not necessary for brass, since the

Fig. 10—FRONT TOOL FOR BRASS

parting tool can do all the work that the front tool cannot tackle. In any case, it is always unwise to use on brass a tool with a broad face, since that metal is inclined to "chatter" and leave a series of ridges if too broad a surface is brought to bear against it.

The parting tool for brass (Fig. 11) is similar to that used for the other metals, except that when cutting iron and steel the tool is ground away to form a lip just behind the cutting edge; with brass this lip is unnecessary.

Fig. 11—PARTING TOOL FOR BRASS

It should be noted that when steel and wrought iron are being turned in a lathe it is necessary that a stream of soapy or soda water should run on to the cutting edge of the tool. This is to prevent the tool overheating and losing its temper.

With cast iron, brass and wood a cooling liquid is not necessary.

Making Tools.—Lathe tools are made of cast steel known as tool steel. A small set of tools is included in

the estimate of cost given at the beginning of the article, but when these are worn out, if the reader wishes to make his own he can buy suitable steel and forge them. Lengths should be cut off and heated, and then hammered out on an anvil to as near the shape required as possible. The steel should not be made too hot or it will become brittle and break away in small chips when used for cutting. Cherry-red is the colour to which the tool should be heated, but the worker must bear in mind that the thinnest parts of the tool get hottest first, and may easily overheat if not watched. After the tool has been hammered out it should be allowed to cool slowly, in the process of which it will get thoroughly soft, when it may be filed or ground to the shape required. If a grindstone is used the amateur should avoid overheating the metal by rotating the grindstone too quickly. It is easy to do this on a bench grinding wheel, unless care is taken. When the tool is the right shape it should be hardened in the following way: 2 or 3 in. of the cutting tool should be placed in the fire and heated again to a bright cherry-red. About 1 in. of it should then be held vertically in cold water for several seconds. Pulling it out of the water, the tool should be rubbed with emery cloth. Watch the tool and you will notice that it changes colour as the heat from the uncooled end travels towards the point of the tool. First comes a pale yellow band, then a deeper yellow, then a brown colour, then plum colour, then purple and then blue. The darker the colour is, the softer the tool will be. When the dark yellow colour reaches the point of the tool, the whole should be plunged deeply into cold water and allowed to stop there until it is cold. Hardening is a process learned only by practice and experience, but an attempt can be made first on waste pieces of steel, so that good tools are not spoiled.

Driving and Holding Devices.—In the preliminary description of the cycle of operations for working a lathe, mention was made of a face-plate with a driving-pin attachment catching the tail-end of a carrier fixed to a spindle. This method can be adopted for most work which is run between the centres of the lathe, but it is obviously useless for turning a flat plate or a cylinder which already has a hole through its centre.

For such jobs as these the face-plate must be used, or a device called a chuck. Both the chuck and the face-plate screw on to the nose of the mandrel. A chuck is a kind of face-plate fitted with jaws which close down on the job to be held, and grip it as tightly as a vice. Included in the original estimate of £3 is a three-jaw chuck. If the reader can afford to buy a self-centring chuck he will be amply rewarded, for it will save him hours of time which otherwise will be spent in trying to centre up jobs on an ordinary chuck, and enable him to tackle jobs otherwise beyond his capacity. In any case the reader

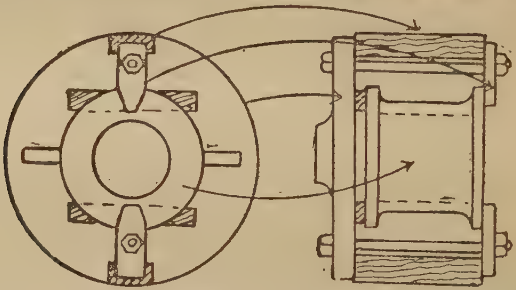


Fig. 12—CYLINDER SET UP FOR BORING ON FACE OF PLATE

should endeavour to get a drill chuck—these are not expensive—which will take the standard taper drills. The jaws of a chuck are operated by means of a box spanner. In the ordinary chuck each jaw is moved separately, but with the self-centring chuck one key moves all the jaws. It requires both patience and skill to centre up a job in the former type.

Some jobs, such as cylinders, are too long to be held securely in a jaw chuck, and these should be bolted down to a face-plate. The cylinder is fixed to the face-plate by two bolts passed through the bolt holes on the face-plate. The nuts of the bolts fasten down on to clamp-plates which are supported under their outer ends by packing pieces. Fig. 12 illustrates this operation. Note that if the cylinder is to be bored, packing strips will be necessary between the face-plate and the cylinder, to leave room for the tool to come through.

The amateur will save himself money and gain experience if he tries making special chucks out of hard wood. A wooden cup chuck can be used for small brass and other metal pieces over which only a light cut is needed. The hole is tapered slightly to afford the necessary grip, and the work to be turned is knocked lightly into it. The screwed hole of the chuck fits on to the mandrel nose. Chucks for a variety of purposes can be made, and since the mandrel nose of the machine we are describing is only ½ in. by 16 threads, a tap suitable for making the chuck fit the mandrel nose is an inexpensive item.

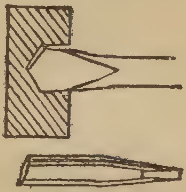


Fig. 13—DRILLING

Drilling and Boring.—Both drilling and boring can be done with success on a lathe. These are two methods of drilling on a lathe. The first is to hold the drill in a chuck and feed the work towards the drill by advancing the saddle; and the second is to fix the drill in the slide-rest and feed it towards the work, which latter is fastened to the chuck or face-plate. Unless the worker has a drill chuck or self-centring chuck the latter is the better method.

In the first method a twist drill can be used, but in the second a diamond-pointed flat drill, similar to that shown in Fig. 13, will be needed. The drill should be slightly smaller than the size of the hole required, the work being finished off with a boring tool. The latter, of course, only cuts on one side of the hole, so it will be necessary, therefore, to see that the cut is gauged accurately by testing the inside of the hole with a pair of inside callipers set to the correct diameter. As with other tools, care should be taken to see that the under side of the boring tool clears the side of the hole being bored. A suitable tool is shown in Fig. 14.

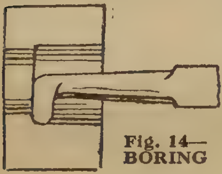


Fig. 14—BORING

Measuring Tools.—Among the accessories which are absolutely essential to the amateur and professional mechanic are measuring appliances. A steel foot-rule

divided into eighths, sixteenths and thirty-seconds of an inch is indispensable. A steel rule is better than a wooden one, as the graduations are finer and more accurate. Fig. 2 shows a pair of odd-leg callipers, the use of which has already been described.

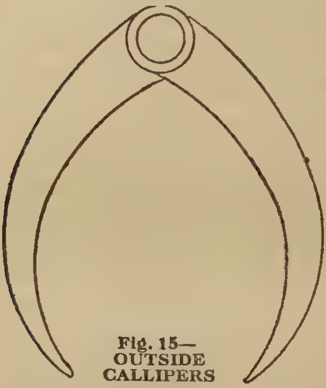


Fig. 15—OUTSIDE CALLIPERS

Fig. 15 shows a pair of ordinary outside callipers, which are used for measuring the diameter of a cylindrical piece of work. The calliper legs are opened until they just touch on both sides of the work without pressure being applied. With one leg placed against the end of the rule the diameter of the work can then be gauged.

If it is wished to turn a spindle down to, say, $1\frac{1}{2}$ in. diameter, the callipers should be set to that measurement on the steel rule and the cuts on the material can then be made until the callipers just slip over it. The amateur will be wise not to attempt to measure with the callipers while the work is still running. Only experts can get the feel of a spindle while it is still running.

Fig, 16 shows a pair of inside callipers. These are used to measure the internal diameters of holes, and they are employed in a similar manner to the outside callipers. *See* METAL-TURNING.

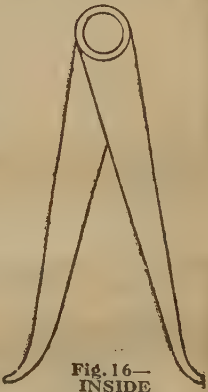


Fig. 16—INSIDE CALLIPERS

LOCKS AND KEYS.—In the article dealing with DOORS instructions are given for fitting a rim lock. Here we give further information about locks and their defects, and describe the process of cutting keys of the simpler sort.

Usually the entrance door of a house is furnished with a pin-tumbler lock, generally of the kind known as a night latch. It can be operated from the outside only by a key, but from the inside by turning or sliding a handle. If the cylinder becomes loose, the latch case at the back of the door should be unscrewed and removed; now examine the two long screws that go through the door and enter holes in the cylinder. If the screws are loose they can be tightened up so as to draw together the cylinder and the recessed washer at the back, which will cure the defect. Pin-tumbler locks seldom give trouble in any other way; the cylinder contains an intricate piece of mechanism and should not be taken from its shell. We have mentioned elsewhere the desirability of fitting a dead-lock to a glass-panelled entrance door, in addition to the night latch usually provided. The cutting of a key for the pin-tumbler lock is a task that the amateur cannot tackle; at the ironmonger's it is done by the aid of a machine which uses the spare key as a gauge. This makes it easy to form the correct notches in the blank by merely turning the handle of a grinding wheel. If a spare key is not available the lock itself must be taken to the locksmith.

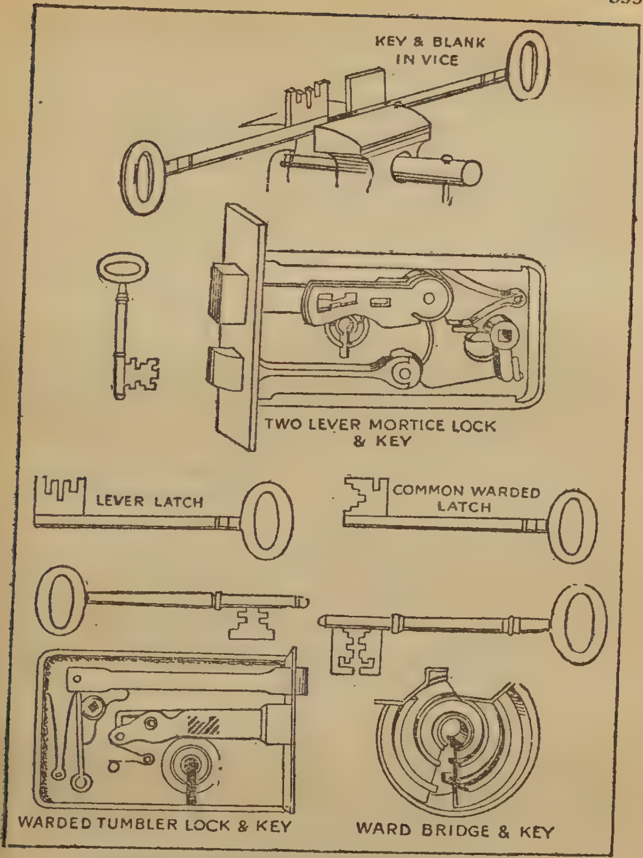
Owing to the security it affords against picking, and the convenience of its small key, the pin-tumbler latch has almost ousted the older form of night latch. The latter, however, is found in many of the older houses, and occasionally the home mechanic may be called upon to replace a broken spring or cut another key. Unscrew the lock and remove its cover plate, which will then be accessible. It is held in place by short screws that enter threaded holes in the lock-case. Observe where the spring is located, as this will make it easier to replace it later. Take the broken spring to the ironmonger as a pattern for the new one, which is then to be put in position on its pin and the cover replaced. If in the process the bolt or tumblers or levers are displaced, they are to be put back as before and the key tried in the lock to make sure everything is in order. Do not omit to oil the working parts of a lock whenever it has to be taken apart.

The springs of mortise locks and rim locks may become so weak in time that they offer very little resistance to

the pressing back of the bolt. In consequence the door bangs when pushed to, the bolt passing the striking plate so easily that the door is not checked enough to prevent this violent impact. The remedy is to remove the lock and fit a new spring. In the case of a mortise lock, after the handle and spindle are taken out, the outer plate or face-plate is to be unscrewed and removed; the plate fits into a housing or recess made in the edge of the door. Then the lock itself is unfastened and withdrawn. When removing or replacing the spring, take care that the collet with the square hole for the handle spindle is correctly positioned with regard to the spring and the bar that come between them. Usually, when the cover-plate is taken off, the collet jumps out of place under the pressure of the spring against its lever.

Should the small springs of any tumblers in a warded lock be broken, the amateur may attempt repair. A piece of spring steel of a suitable length, width, and gauge is prepared and softened, and then bent to the proper shape, as shown by the old spring; the new one is then hardened, and inserted at one end in the saw-cut of tumbler. This is opened by tapping or pressing into it a small cold chisel or a screwdriver to eject the old spring, and closed on the new one with a light blow of a hammer. Make sure that the edge of the new spring does not stand up above the surface of the tumbler. The tumbler is to be gripped in the vice during the opening or closing of the saw cut.

Levers and Tumblers.—We have referred to these parts of the lock, and some explanation is needed. The cheaper sorts of lock are "warded," or provided with concentric rings around the key pin. These rings or wards are intended to prevent the use of any key not furnished with slots or steppings corresponding to the wards of that particular lock. A suitably shaped "skeleton" key—one of which all but the outer part is removed—will enter and unlock not only this lock but others of similar construction. To add to their "security," the keys of warded locks are sometimes nicked or notched on the outer edge to engage with a flange on the ward, but such nicks may on the other hand be merely dummy ones. The practice has grown up of introducing such false slots and notches into keys, and



LOCKS AND KEYS OF DIFFERENT DESIGN

the complexity of its key is seldom a safe guide to the quality or workmanship of a lock.

This question is merely one of price, however, for good locks by reputable makers are necessarily more costly than the flimsy products which are sold to the unsuspecting amateur or fixed by the builder who "works

down to a price." It is the inside of the lock that matters, and this is usually taken for granted. Lever locks offer more protection, for in place of the tumbler of the warded lock there may be four or more levers, each corresponding to a "step" on the edge of the key. Before the bolt can be shot the levers must all be lifted so that their slots—each in a different position—register with a lug on the bolt.

Unless the steps of the key correspond in location and in height with the levers the lock cannot be operated by that key. A four-lever lock permits of 24 different arrangements of the levers of a given series; a five-lever lock of 720 different combinations, merely by re-arrangement of the same levers. Thus it is clear that a couple more levers give a great deal more security from picking of a lock or the chance opening by a false key. A six-lever lock—one fitted to a safe, for example—could be opened by one key only out of 4,320 that might be tried with different combinations of the same six steps. If the manufacturer reduces the height of one of the steps he can ring the changes again, and so on. One reason why the pin-tumbler lock has become so popular is that its construction allows of a great many different combinations of its pins.

Key-cutting.—Latch keys are the ones that are most often lost or mislaid, so we will describe the process of cutting a new one for a rim night-latch of the lever type. A blank can be purchased at an ironmonger's for a few pence; see that it is of the same sort as the pattern—with a barrel or with a solid pin, as the case may be—and of the proper dimensions. A blank and the pattern key for which it is suitable are shown in the diagram. The tools needed are a flat parallel file, bastard or second cut, and a couple of warding files. A hacksaw is handy if the worker can use it deftly. A pair of outside callipers is used for measuring the key and testing the work in progress.

Grip both blank and pattern in the vice, lengthwise, so that the bows are at the outside and the squares together. In the case of a key with a barrel both the blank and the pattern can be pushed on to opposite ends of a short piece of iron rod of the proper size to fit loosely in the barrel. They are then screwed up in the

vice. Test the outside dimensions of the blank and cut it down almost to the same size as the pattern, using the flat parallel file for this operation. It should be left a little too large, to be on the safe side. Next, with a warding file, begin on the lowest step, filing away steadily until almost the proper depth has been attained. Deal similarly with each step in turn, cutting the notches square with the sides of the key. The file should be fixed in a handle, or the job will be a tiring and uncomfortable one. Beware of removing too much metal, and compare the blank often with the pattern.

When all the steps have been cut, reduce them finally to the exact height of those in the pattern key, file off any burrs on the face of the new key, and try the latter in the lock. Should it fail to operate the bolt, examine it minutely to find out where it differs from the pattern. Observe if the barrel is clear and unobstructed, and make sure that the key is not too high to turn easily beneath the top of the lock-case. Do not reduce any of the steps until all other possible defects have been excluded. Notches may not be quite wide enough, perhaps. Compare new key with old, step by step, when the callipers should indicate any difference. A touch or two of the file will probably put the key right.

As soon as the key is got to work satisfactorily, the steps may be rounded off at the sides a little, but their heights must not be reduced in any way. If a pattern key is not available, the job is more difficult, for the lock must be opened and the steps cut one by one to fit the levers themselves. An examination of an actual lock will make the matter clearer. Some familiarity with locks should be acquired before tackling a job of this sort. A drawer lock of the lever type would be a suitable task for a first attempt. The construction of typical locks is made clear by the accompanying diagrams.

METAL-TURNING FOR THE BEGINNER.—The amateur who buys a lathe includes among his first jobs, if he is wise, a set of spare parts. A lathe is a simple machine to dismantle, and with very little trouble he can soon make a list of the parts which, should they become worn or broken, he himself could replace. It is of little use waiting for the mandrel bearings to become worn before making a spare set. Accidents, too, cannot

be foreseen, and if, by some mischance, the cone pulley should crack, the lathe would be useless. The obvious thing is to have in stock such replacements as one may need. Here is the way to make a new cone pulley. The dimensions will depend on the size of the pulley on the lathe, but the drawing on page 360 will serve as a guide to the various operations necessary in making a suitable pulley.

Note the dimensions of the pulley. The largest diameter is $2\frac{3}{4}$ in. A piece of cast iron about 3 in. in diameter and 3 in. long will be suitable, and in all probability can be obtained from a local engineering works or foundry. A more expensive way would be to send a sketch of the cone pulley to one of the firms advertising in the model engineering Press, and to obtain a casting from them, but by using a little tact and determination, odd pieces of metal for most of the beginner's small work can be obtained from local sources. If one can get the works manager or foreman interested, he may furnish all sorts of odds and ends that the amateur needs.

We will assume that we have been able to obtain a piece of cast iron 3 in. long by 3 in. in diameter and that the pulley we wish to make is similar to the one in our drawing. A gauge to fit the belt grooves and another of the same size as the lathe mandrel will need to be prepared at the beginning.

If we had a carrier large enough to take 3 in. diameter, it would be a simple enough matter to centre up our round of cast iron and turn the pulley on the centres. But the tail and the adjusting screw of a 3-in. carrier would stick out too far and foul the bed of our lathe, so we must employ another method to drive the job. We will use the chuck; but first take out the live centre so that it will not be damaged, and put the driving belt on the slow speed.

Centre the material in the chuck in the usual way. We have a fair amount of material to spare, but that should not make us careless about getting the work as central as possible. It is far easier to take a cut over a well-centred job than it is over one that is badly centred.

The piece of cast iron, with the exception of one end, is still just as it came from the foundry, so that when we

take the first cut we must, if possible, get under the "skin." The skin contains particles of sand, and nothing rubs the edge off a tool so quickly.

The job is to be centred up in the chuck with the rough end facing the tailstock, which has been pushed right to the far end of the lathe, out of the way. Fix the front tool in the slide rest, parallel to the bed of the lathe, and run the saddle up close to the job. First we must face up the rough end, so we wind up the saddle towards the headstock close enough to take a cut, and then make the cut by turning, with the left hand, the slide-rest handle. Keep the right hand on the saddle handle to prevent the saddle from running away. Run the cut right across the end of the material by gradually advancing the tool with the slide-rest handle.

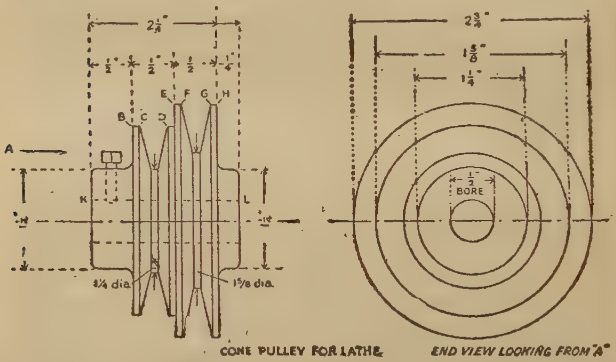
When the cut has been made, test the end with a steel rule to see that it is square. If it is not, take a further light cut until it is square. A tiny nipple will be left, probably, exactly in the centre of the end of the material.

Now substitute for the front tool a left-hand side tool, and take a cut along the diameter of the round. Get below the skin but do not take away any more material than is needed because we have not too much to spare. Set the outside callipers to $2\frac{7}{8}$ in., *not* $2\frac{3}{4}$ in., and turn the material down to the larger diameter. The reason for this will be apparent later.

Next mark on the turned surface, with a piece of chalk, a line $1\frac{1}{8}$ in. from the end that has been faced up. This is going to be the outside edge of the larger pulley, the point where the larger pulley joins the smaller. Set the outside callipers now to $1\frac{3}{4}$ in. and take cuts along the diameter of the metal up to the chalk mark, until the callipers show that we have now reduced this part of the job to $1\frac{3}{4}$-in. diameter. Along this piece which we have just turned, mark with chalk a line $\frac{9}{16}$ in. from the faced-up end and reduce this piece to $1\frac{3}{8}$-in. diameter.

We must now cut away as much of the belt grooves as we can, so the operator will have to bring back the slide-rest towards him as far as possible and get the saddle well up towards the chuck. Bring the tool round to the position used for turning between the centres—that is, at right-angles to the bed. Use the front tool; the narrower it is the farther into the grooves

it will be possible to cut. Before attempting to cut the grooves, however, mark off carefully the exact positions B, C, D, E and F shown on the diagram. The worker must be very careful to keep to these markings, for although we have plenty of material to spare at the ends, the middle points cannot be altered. Remember too that the point E is now $1\frac{1}{8}$ in. from the faced-up end but when finished it will be 1 in. Mark this point E first; then mark B $\frac{1}{2}$ in. from it, and F $\frac{1}{16}$ in. from it on the



WORKING DRAWING FOR MAKING CONE PULLEY FOR LATHE

headstock side. C is $\frac{1}{16}$ in. from B, and D $\frac{1}{16}$ in. from E. The chuck is probably gripping on G and H, so those will have to be left for the time being.

Now cut as deeply into the grooves as is possible, remembering that the sides of the groove taper into the centre, which, when finished, will be $1\frac{5}{8}$ in. in diameter on the larger pulley and $1\frac{1}{4}$ in. on the smaller. A gauge ought to be cut to fit the grooves in the cone pulley of the lathe; by applying this to the work in progress we can test the grooves we are cutting. When we have cut the grooves as deeply as we can, the tool is taken out and the saddle pushed out of the way.

The next stage is to drill a hole through the centre of the work. Use a diamond-shaped drill which will cut a hole less than $\frac{1}{2}$ in. in diameter. The hole will have to be finished off with a boring tool. The centre

of the job will easily be seen, since you have faced up the end and left a small "nipple." File off the nipple before pressing the drill into the metal, otherwise the drill will rotate slightly and make the hole uneven and too large.

When the drill has gone right through the work replace it with the boring tool and take a light skim through the hole to make it true, testing it with the inside callipers. Before beginning to turn the pulley the worker should have made a gauge of exactly the same size as the mandrel on which the pulley is to fit. The hole should now be bored out to the required size, and the gauge should slip in with an easy but not loose fit.

It may not be considered absolutely necessary, but it is advisable at this point to take the job out of the chuck and reverse it, gripping the boss K with the jaws of the chuck and centring it again very carefully. The rough material covering G and H can then be removed and the boss L turned down to $1\frac{5}{8}$ in.

The cone pulley is now ready to be finished off; no further heavy cuts are required. We now need a mandrel —that is, a spindle on to which we can drive the pulley. The mandrel should be made of mild steel or wrought iron, and the main body of it can be, say, 1 in. in diameter. One end of the mandrel will be turned down to $\frac{1}{2}$ in. to take the pulley. It must be tapered slightly towards the headstock end.

Lay the pulley over a piece of piping and drive the mandrel into the bore of the pulley, using a piece of wood to protect the centre-pop of the mandrel from the hammer. Do not force the mandrel in too hard, or the pulley may be cracked.

The pulley being securely on the mandrel, it can now be finished off to the dimensions required. It will run true on the mandrel, and provided no heavy cuts are made it will not slip.

If the lathe mandrel is fitted with a key it will be necessary to cut a key-way along the bore of the hole, but pulleys for a small lathe are generally fitted to the mandrel by means of a set-screw through the boss, as shown in our drawing. This hole through the boss can be drilled and screwed by hand.

A Pair of Candlesticks.—Brass is an easy metal to work, and there are many ornamental as well as useful objects that can be made with it on a lathe. A simple yet artistic pair of candlesticks similar to that illustrated can be produced by even the novice.

Two pieces of brass rod 1 in. in diameter and $4\frac{3}{8}$ in. long, and two flat pieces $3\frac{3}{8}$ in. in diameter by 1 in. thick are all the materials required.

First drill a hole in each of the flat pieces to take a $\frac{5}{16}$-in. screw and tap them out with a corresponding thread. Place them on one side—they will form the bases of the candlesticks.

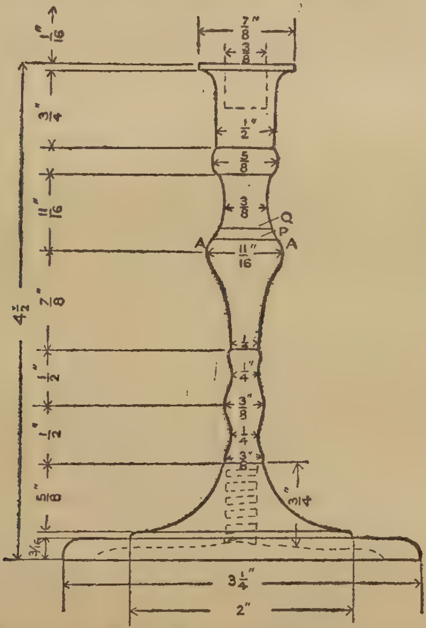
Give the lathe a thorough oiling and put the driving-belt on the high-speed pulley before you do anything else.

Now centre up the rods and, placing a carrier over one of them, insert the rod between the centres of the lathe with the driving pin on the faceplate. Reduce the diameter of the rod, excepting at the carrier end, to $\frac{11}{16}$ in., making the last cut a finishing cut.

Now take the rod out of the centres, fasten the carrier on the other end, and replace it in the centres. Face up the end of the rod and turn the end piece of the rod to $\frac{7}{8}$ in. Mark off a point $\frac{13}{16}$ in. from this end and take cuts at that point until the diameter is $\frac{1}{2}$ in. Note that the top of the candlestick is bell-shaped, and it tapers gradually outwards towards the top and then joins up to the lip at the top with a curve. By moving the saddle towards the tailstock—that is, from left to right —the worker can shape the candlestick as shown in the drawing. Having completed this part of the work go back to the $\frac{13}{16}$-in. mark and work the saddle to the left of it, reducing about $\frac{1}{2}$ in. of the length of the rod to $\frac{5}{8}$-in. diameter. Mark a point $1\frac{5}{8}$ in. from the end of the rod and turn to the shape shown in the drawing, following the dimensions accurately. Marking the work always from the right-hand end, the shank of the candlestick can be made to the dimensions shown. When this has been done, reverse the work between the centres and turn the other end to $\frac{5}{16}$ in. in diameter. This end must be screwed to fit the base, either with a die or with a chaser, but before cutting the screw in it we must reverse the job in the centres and finish off the shank of the

candlestick. A piece of smooth emery paper will soon give it a good polished finish. By the way, note that P and Q are merely tool marks giving an added decoration to the candlestick.

Now screw the shank into the base. It must, of course, be a tight fit. Fasten the carrier to the tapered end,



WORKING DRAWING FOR SHAPING CANDLESTICK

protecting it by means of emery cloth wrapped round it and a small piece of copper between the brass and the screw of the carrier. Set it between the centres again, the base at the tailstock end.

Take light cuts over the base, shaping it as shown in the drawing. When this has been reduced to the right dimensions the bottom of the base must be squared up and recessed. The candlestick will not stand evenly on

a mantelshelf if we leave the bottom of the base solid. About ¼ in. from the outside diameter of the base begin the recess and carry it as close up to the centre as practical. Now polish the base.

Only one thing further is needed to complete the candlestick, and that is to make the hole for the candle. This should be ⅜ in. in diameter and ⅜ in. deep. The job could be done by holding the base in the chuck and using a drill, but great care would be needed, otherwise the shank might break off at its weakest point. It would be better to hold the shank in a vice and drill it by hand. If the worker possesses a drill chuck, a twist drill could be used and the job fed towards the headstock by advancing the tailstock. The back centre would have to be removed and a block of wood placed between the tailstock and the base of the candlestick. Provided the block and candlestick were gripped firmly there should be no fear of the shank breaking off. The candlesticks described are actual copies of a pair of old French ones. They are distinctively ornamental, and hold a small candle which can be used to supply the heat for melting sealing wax when required.

PIERCED WORK IN METAL.—Fretwork in metal, or, as it is technically called, metal-piercing, offers a very delightful field of work to the amateur who has already attained to some proficiency in fretcutting in wood. When the work is properly done, metal is not so difficult to saw as might at first be imagined and it offers advantages as a medium of expression that are not to be found in wood.

Since metal has no grain, it permits of greater freedom in design and working, while it is capable of being adapted to patterns on a grand scale—as in large ornamental hinge-plates and lock plates—as equally as to work of the smallest and most delicate description, such as jewellery and other small articles in gold and silver. Metal-piercing offers a ready means of recapturing the spirit of artistic craftsmanship of a bygone age. To-day, stern utility demands that a lock-plate or hinge-plate, for instance, shall be as plain and as inconspicuous as possible, but in the Tudor and Stuart periods these articles not only boasted a wealth of intricate design, but they were frequently of extravagant dimensions—

in the case of chests and coffers, for instance, often covering nearly the whole of the front and lid—and practically all in pierced metal work.

Any descriptive text book on ornamental metal work will furnish the amateur with designs of the highest quality, often taken from celebrated pieces of antique furniture; while a veritable education in this respect can be picked up by visiting museums and exhibitions of handicrafts. If the amateur has some skill in sketching, he can copy a design that takes his fancy, and often he will be able to obtain permission to take a rubbing of a fine specimen of pierced work, which he can afterwards reproduce himself.

Perhaps the most popular metal for work of this kind and certainly one of the most suitable for a beginner is brass. Sheet brass is sold in various thicknesses, and the gauge used should be suited to the work for which it is intended. As a general rule, the thickness of the metal will increase with the size of the work, so that for a large pierced lock-plate $\frac{1}{16}$-in. stuff may be required. Judgment in selecting materials can only properly be obtained by experience.

Metal-piercing Tools.—The tools for metal-piercing are simple. For the actual cutting a strong 12-in. fretsaw can be used, but for really serious work a proper piercing saw will be found much more convenient. It has much less sweep than a fretsaw, and is provided with a sliding frame, which enables the distance between the jaws to be varied at will; this enables odd lengths of broken blades to be used up. A very strong and serviceable piercing saw can be obtained for 3/- or so.

The amateur should make a point of using only the blades that are specially made for metal-piercing; ordinary fretsaw blades, to which they are similar and which are sometimes used instead, will be found to break too easily to be economical; they also give an irregular and jagged cut and are very slow in use. The piercing saw has fine and close-set teeth, which cut through soft metals fairly easily when the saw is used correctly; gauge 00 will be found the most useful all-round size. These saws can also be used for cutting xylonite, erinoid, vulcanite and similar materials.

A sawing-table or rest for supporting the work will be needed. It is provided with a V-shaped slot and is clamped on to the edge of an ordinary kitchen table or bench; it will be found described in the article on FRETWORK.

A fretworker's or a hand drill will also be necessary for making holes for the insertion of the blade in the metal. The plain diamond-shaped points are apt to be snapped by the pressure required to drill through metal, and it is better to use twist bits instead, which can be obtained in a wide range of sizes, down to an almost microscopic gauge.

The remainder of the outfit includes a set of fret-worker's files for cleaning up rough edges and finishing the work; a few minute files, known as needle files, for use in small crevices; a small vice for holding the work while it is being finished; a couple of small screw cramps for firmly securing the work to the cutting board while it is being sawn; one or two pairs of pliers (both long- and short-nosed), for bending, rolling up the tongues of ornamental hinges, and so on; a pair of metal-worker's shears for cutting thin sheets of metal roughly to size (for thick sheets a hacksaw or special metal-slitting saw will be found useful); a sharp scriber for marking lines on the metal; a soldering kit or copper rivets for joining up the finished work, if it is not in the flat; carbon paper for transferring designs to the metal; and a little fine pumice powder for polishing.

Paste for Patterns.—If a paper pattern is used, a special paste must be employed to stick it to the metal, ordinary paste or gum not being secure enough. This paste can be made as follows: Soak a lump of gum arabic (1 part) for several hours in cold water; when it has dissolved, stir in 4 parts of granulated sugar and 1 part of starch which has been mixed to a thin paste with cold water. Boil the mixture until it becomes glutinous, adding more water to bring it to a workable consistency.

First of all, the design must be transferred to the surface of the metal. The simplest way of doing this is to stick on the pattern with the special paste, but it must be allowed to dry thoroughly before the metal is worked. If the design is to be reproduced more than

once it may be traced by laying it upon the metal, with a sheet of carbon paper in between, and going carefully over the outline with a pencil; or a stencil can be made by piercing holes along the lines of the pattern and rubbing french chalk through the holes. The lines must then be made more prominent with black paint or brunswick black applied with an artist's fine hair pencil. A more professional method is to go over the carbon or chalk marks with the scriber or a fine marking awl, incising them clearly into the metal, but great care and practice are necessary if mistakes are to be avoided. The sheet of metal should now be clamped firmly to the top of the sawing-table.

Technique of Fretcutting.—For general instructions for drilling and sawing the reader is referred to the article FRETWORK. Fretting in metal, however, demands a slightly different technique from the same operation in wood. The saw must be moved gently but rapidly up and down, but very little forward pressure should be exerted. It is usually difficult to turn a very fine corner sharply, as can be done in fretwork, and so the corner can be left fairly blunt and afterwards trued up with a triangular file. The saw should frequently be rested, to prevent over-heating, and for the same purpose it must be lubricated every now and then, either with oil or by rubbing with a piece of beeswax.

The design having been cut out as accurately as possible, the work must be gone over with the files in order to correct the outline, sharpen the corners and rectify blemishes and errors. When it at last meets with the amateur's complete approval, it is ready for polishing. First remove the paper pattern, if such has been used, by dipping the plate in hot water. Then lay it upon a flat piece of wood and rub all over the surface with a large flat cork dipped in moistened pumice powder. The final polishing strokes must all be in the same direction, in order to give a kind of "grain" to the surface of the metal. A very fine silky finish can be obtained by rubbing the work last of all with a little Tripoli powder and oil.

If the article is in several sections that it is intended to rivet or solder together, narrow flanges must be left for this purpose in convenient parts of the design. A

flange can be bent over to any angle required by laying it upon the top of a rectangular block of hardwood so that it overhangs the edge by the required amount, and tapping it with a hammer or mallet. Small flanges can

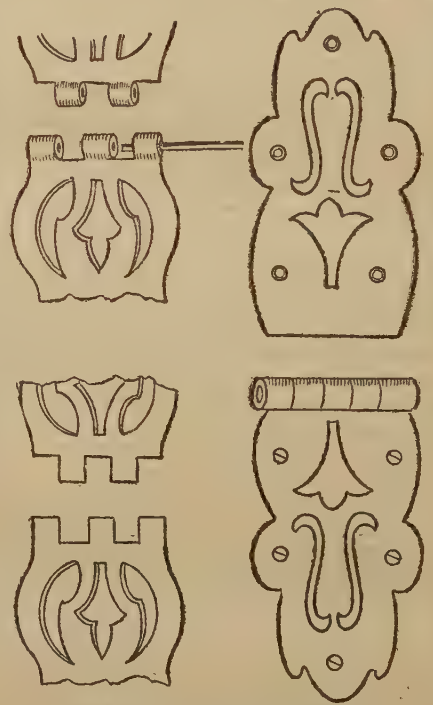


Fig. 1 Fig. 2

ORNAMENTAL HINGES

be turned over with the pliers, or by holding the work in a vice to a line marked with a scriber and turning the flange over one of the jaws of the vice with a few light taps. If a strip of hard wood is held against

the flange to receive the hammer blows, a perfectly flat and regular turn-over can be obtained. The neatest way of attaching a flange to the adjacent side of the article—such as in the corner of a box or casket—is by sweating. The two surfaces must be tinned evenly all over with solder, then coated with flux, and laid one upon the other. The hot soldering bit is laid upon the top, when the solder will soon run and effect a very strong joint. *See also* SOLDERING.

A Pierced Hinge.—One of the simplest articles that the amateur can try his hand at making is an ornamental hinge. Each half of the hinge must be provided with a number of rectangular flanges, arranged so that they interlock when the halves are placed together. These flanges can be easily rolled up with a pair of round-nosed pliers into the shape of a hollow cylinder; a piece of stout wire is then passed through, and its ends are burred by hammering in order to prevent it from coming out (*see* Fig. 1).

A simpler method still of making an ornamental hinge in pierced work, applicable to an article such as a box or chest that is already fitted with ordinary butt hinges, is by the addition of false hinge plates. These are flat pieces of metal, pierced with any desired pattern and having a perfectly straight edge on one side which is brought up close to the knuckle, or centre part, of the hinge, and secured with screws, as is shown in Fig. 2.

SCREW-CUTTING.—This is a simple enough operation if one has a screw-cutting lathe, but to the amateur who has a simple lathe only, it sometimes presents a problem. Two methods are open to him:—

(1) To cut the screw with a hand chaser while the work is in the lathe;

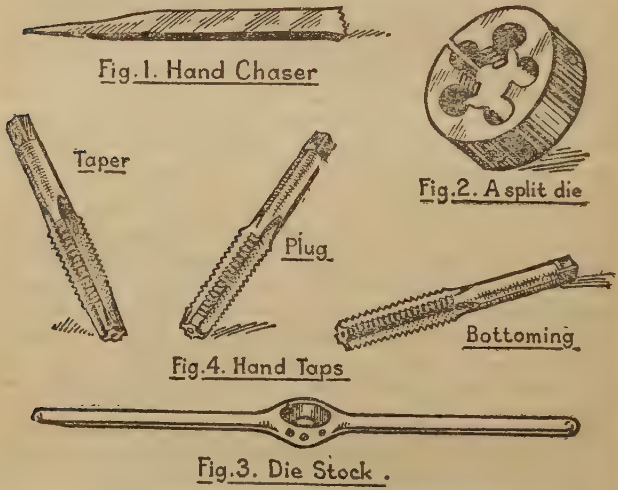
(2) To use a die to cut an external thread, or a tap to cut an internal thread.

The cutting of threads with a hand chaser is no easy task for the unskilled, particularly on short lengths; here no sooner is the chaser applied to the work than it has to be removed, owing to the short distance it has to travel. A typical hand chaser is shown in Fig. 1. The method of use is as follows:

A piece of wrought iron, or other suitable material,

square in section, with a right-angle bend in it, must be procured to act as a rest. The shank of it is placed in the slide-rest with the right-angle piece parallel to the work in the lathe. The machine is set running, and with the handle of the chaser held firmly in the right hand and kept firm by the left hand, the chaser is pushed forward until it takes a cut on the material. The cutting edges of the chaser must, of course, be parallel with the work.

When it has finished its first cut the chaser is with-



VARIOUS TOOLS FOR SCREW-CUTTING

drawn and the operation repeated. Care must be taken with the second and third cuts to see that the chaser engages in the first one, otherwise a double thread will be formed. The cutting of internal threads with a chaser is beyond the powers of the average amateur.

Use of Dies.—In order to make clear the process of cutting an external thread with a die, it will be as well to describe a die. It is a round, flat piece of hard steel, the centre of which has been drilled out and screwed.

Parts of the screwed portion are cut away by holes drilled through it along its length. The number of holes depends on the size of the die. The remaining portions of the screw are thus left with sharp cutting edges. Fig. 2 shows a typical die; note that the die illustrated is split down one side—the reason for this will be explained later. The thread of the die is tapered at one end of the hole in order that when it is applied to the work to be screwed it may start more easily. The die fits into a die stock, shown in Fig. 3, and is fastened in it by means of a small set-screw.

When using the die for cutting a screw thread, the work should be gripped firmly in the vice with the portion to be screwed pointing upwards. It is essential that the die should go on to the work square; when first applied to the work get it started with the hand, before fixing the die in the stock. It is the initial stages that cause trouble in using dies, but if care is taken to follow the above instructions no difficulty should be experienced. If the die is not given a good start, it will cut away the material without forming a thread. When the die has passed right along the work it should be run back again. The value of the split may now be explained: on the die-stock are two adjusting screws which, when tightened. bear on the two opposite sides of the split and draw them together, thus decreasing the internal diameter of the die. When the die, after this, is again applied to the work it will cut a deeper thread. After each cut has been made the screw should be tested for size by applying it to the work it is to fit, otherwise the screw may be made too small. Always use a little oil for lubrication when cutting with dies.

Internal Threads.—Taps are used to cut internal screw threads, and they are a good deal easier to manipulate than dies. In appearance taps are much the same as ordinary screws, except that four or more grooves are cut along their entire length. They are sometimes made singly, but generally in pairs or in threes. Fig. 4 shows a typical set of three taps. The first tap is called the "taper" tap, the next one the "second" tap, and the third the "bottoming" tap. The taper tap is tapered the whole of its length, except for the last or uppermost two or three threads. The second tap also is tapered,

but not so much as the former, while the bottoming tap is cut the exact size of the screw required. The manner of tapping a hole is as follows:

Fix the work in the vice with the hole facing upwards. Place the taper tap in the hole, after giving it a good oiling, and knock it gently into the hole, taking care that it enters square. On the top of the tap is a square, and on this part fits a wrench. A box spanner may be used, but this is not so satisfactory, since it is difficult to keep the tap vertically in the hole unless it is evenly balanced at the top.

A useful tip for getting the tap square with the hole is to run over the tap a nut which is the same size as the screw. If the bottom of the nut is kept flush and square with the face of the hole being tapped, the tap will go in perfectly straight. Screw in the tap steadily, occasionally reversing the motion to clear away metal that has been removed by the tap. Oil it well. When the tap has been passed right through the hole, take it out and insert the second tap in the same manner, and afterwards do the same with the bottoming tap. In using the first tap care should be exercised not to force it through too hard or too quickly. If it is forced too much it will not bite into the metal, but merely act like a reamer and make the hole larger. Once the worker feels the tap bite into the metal, he may turn it round steadily.

Circular dies are made in two diameters, $\frac{13}{16}$ in. and 1 in., for the smaller sizes of thread with which the amateur is likely to deal. A die-stock of the corresponding size is essential, of course. Whitworth dies up to $\frac{5}{16}$ in. are to be had in $\frac{13}{16}$ in. diameter; or from $\frac{1}{8}$ in. to $\frac{5}{8}$ in. in the larger size die. B.A. dies are sold from 0 to 8 in either $\frac{3}{16}$ in. or 1 in. size. Some of the commoner gauges of die are obtainable also with left-hand threads, and taps to correspond are made. Ordinarily, of course, it is the right-hand die or tap that is used.

After use, oil the dies and smear the taps with petroleum jelly. Keep them separate in shallow wooden or metal boxes, away from other tools, which might damage the cutting edges. Sets of taps and dies are put up in wooden boxes, but these are expensive and hardly called for by the work which the average handyman undertakes.

It is more convenient to buy a single die and a tap—with the proper die-stock and a tap-wrench—as and when required. Other taps and dies are easily added as needed.

SOLDERING.—Until the popularity of wireless experimenting and the building of receiving sets put a soldering-bit into the hands of many thousands of novices, soldering was a great deal of a mystery to the average handyman. Many a one started out in high hope with his copper bit and his flux, the bit bright as a new penny. Only too often a little experience in the art—for it is an art as well as a science—left him disillusioned. The once bright soldering iron became burnt and corroded; alternately over-heated and under-heated, it was either too hot for the job or too cool to flow the solder. Soldering jobs proved a nuisance instead of a pride and a pleasure to the amateur in many cases. Yet the essentials are few and the technique is easily acquired with a little patience.

Cleanliness is a pre-requisite for all soldering jobs; we mean chemical cleanliness, the surfaces to be united being free of paint, lacquer, grease, dirt, rust, verdigris, or anything that would prevent a continuous film of solder being applied in intimate contact. Sufficient heat is another essential—the proper degree of temperature, and enough body in the copper bit to retain it long enough for the job. A flux, which causes the molten solder to "run" and to adhere wherever the flux is applied, is indispensable to soldering operations.

Tools for Soldering.—The copper bit or soldering "iron" should be a large one. It may even weigh a pound, though the novice is often tempted and advised to buy a much lighter one. Avoid the common trumpery bits made of a wire rod with a piece of copper of about $\frac{5}{8}$-in. section screwed on to the end. They hold insufficient heat for any but the lightest jobs, and the copper head of the tool becomes loose in the thread and tends to turn and twist at the most inappropriate moments. For light jobs where it is difficult to introduce the point of a large bit, a blow-pipe or the flame of a small spirit blow-lamp is to be recommended as the heating medium. Such inaccessible parts can be fluxed and then receive

a smear of paste-and-flux solder, when all that remains to be done is to apply heat and hold the parts in close contact. This by the way, and we must return to tools.

The bit should preferably be a straight one; a lighter (½ lb.) bit of hatchet shape is useful if a second one can be purchased. An alternative is to buy an adjustable one, whose copper head can be turned through an angle of 90° after loosening a clamping screw. The straight bit is the most generally useful. Electric soldering bits are convenient, especially for small work or for longer jobs like soldering seams. Here, too, the purchaser should be careful to buy a large enough tool.

The writer's experience has been that electric bits may prove somewhat tiresome to use on longish jobs. The temperature mounts rapidly and is not easily controllable; if the current is switched off, the bit soon cools, and the happy medium is somewhat difficult to secure. The trailing flexible, too, gets in the way. A plain bit, therefore, is suggested as a stand-by, and the worker can invest in an electric one if he thinks the outlay is justified. Bits heated by a blow-lamp arrangement we do not think a great deal of, and would sooner use a plain bit and heat it in the flame of an ordinary blow-lamp if no other means were available.

The flux for all and sundry jobs is spirits of salts—dilute hydrochloric acid—in which scraps of zinc are allowed to dissolve until bubbling and effervescence stops. "Killed" spirits thus prepared is used for all jobs except electrical joints; any acid flux is negatived in such a case, and resin or one of the proprietary non-acid fluxes is indicated. When preparing flux leave some of the spirits of salts in its "neat," or unkilled, state for use when soldering zinc, and for other jobs where the usual flux does not prove satisfactory. It must not be lost sight of that spirits of salts is a corrosive poison; it must be kept under lock and key, where children cannot get at it. Prepared liquid flux is sold generally in stoneware bottles; we recommend that it should be transferred to a proper ribbed and coloured "poison" bottle; spirits of salts, whether neat or killed, ought also to be kept in a poison bottle.

The worker should purchase also a block or a large crystal of sal-ammoniac, which is used to clean the copper bit. The hot bit is rubbed on the block, or the latter is rubbed upon all the faces of the bit; then the bit is wiped upon some old hessian, and a drop or two of flux applied, after which it is tinned by pressing on to solder in a small metal pan, or by rubbing a stick of solder upon the heated bit. The sal-ammoniac gives off unpleasant and dangerous fumes when in contact with the hot soldering bit; avoid breathing-in these fumes. The whole operation must be done rapidly before the copper bit can cool. Do not keep the sal-ammoniac in the tool box or anywhere else near metal, for it will corrode any metal objects.

Tinning the Bit.—A shallow pan is used for the solder; the lid of a long narrow tin box will do. When the bit has been heated, it is placed in the pan on top of a little solder, a few drops of flux having first been poured on to and around the solder. If the bit is clean and is hot enough the solder will melt and run on to the face of the bit. Each face of the latter is to be applied in turn to the pool of molten solder and thus "tinned." The process can be assisted by rubbing the bit with an old and grease-free rag. Usually the bit after this job is too cool, and must be re-heated before it can be used to solder a joint.

This consideration brings us to the question of the best way to heat a soldering iron. We prefer the old-fashioned method of pushing it into the heart of a clear fire. When a lambent greenish-blue flame is seen above the bit it is somewhere near the proper temperature, but a test by holding it close to the face is the practical one. A gas-ring is the next best source of heat; a sheet-iron cowl placed over the bit as it lies across the ring will conserve the heat. Failing this, put a full kettle on the ring above the soldering bit. Here again the typical coppery tinge of greenish-blue in the flames will be a guide to proper heating.

Cleaning a Corroded Bit.—The gas flame has a detrimental effect on the copper surface, and the bit may become corroded after prolonged heating. The flame should be lowered while the bit is being merely kept warm, and turned up again just before taking up the bit for a

job. When from any reason the bit becomes corroded, it must be cleaned. Have an old flat file—in a handle—ready, an old rag and the sal-ammoniac. Take out the hot bit, and clean off each face with a few quick strokes of the file; wipe the bit on the rag and apply the sal-ammoniac as directed above. Wipe again and tin the bit. By careful observation of the bit while it is being heated, the corrosion can be avoided. Make a practice of turning down the gas or of taking the bit out of the fire when any interruption occurs. A rub on the block can do no harm, and should follow a wipe on the rag whenever the bit is first taken from the fire at the beginning of a soldering job. Another way of cleaning the iron when withdrawn from the fire is to rub it on a soft brick.

Solder.—This is an alloy of tin and lead with small proportions also of other metals. "Fifty-fifty" solder—half each tin and lead—is the regular alloy, and melts at about 400° Fahrenheit. Softer solder—one-third lead and two-thirds tin; and a harder grade—one-third tin and two-thirds lead—are regularly made. The solder is stocked in rods of about ½ lb. in weight, and this is the best way to buy it. The long, thin strips also sold are sometimes handy, but are rather fiddling to use for any but small jobs. Blow-pipe solder, which is put up in similar thin strips, is a harder alloy of higher melting-point. Paste solder, consisting of powdered metal with a flux, is obtainable in several grades, corresponding to those above mentioned. It is very handy for sweating together parts which a copper bit cannot reach, and for joining small articles. The paste is spread on the previously cleaned parts and heat applied by a lamp or a blow-pipe. We have found it an advantage first to apply a little killed spirits to the surfaces, but this depends on the composition of the paste that is being employed.

Tinning a Joint.—Surfaces must be tinned before they can be united; in the case of tinplate, of course, one can go right ahead after the surfaces have been brightened and cleaned. Tinning is done by fluxing the surface, and holding the hot bit down on it whilst the stick of solder is pressed against the bit. When the solder runs, move the bit about over the surface until it

acquires a film of solder all over the joint. Treat the other part to be united in the same way. Sometimes it is practicable to hold the member over a gas or blow-lamp flame with the tongs, and to rub the stick of solder upon it, the surface having first been brushed with flux.

Sweated Joint.—After tinning two parts to be joined, press them together in the proper location, apply flux at the edges, and press the iron upon them. Maintain pressure until the solder oozes out from the edge; take up the pressure with the end of a file, an iron rod, or something similar; with the hot copper bit take up some solder from the pan, and go round the edge of the joint with the point of the bit. If the job cannot be completed at one go, hold the joint firmly until the solder cools; when the pressure can be relaxed and the copper bit reheated. With the bit again ready, flow more solder round the edge, either from the stick or from the pan, being careful the joint is not loosened or disturbed meanwhile. Press upon it all the while to make sure it does not start.

One fact often overlooked is that parts which have to stand strain should be screwed or riveted together as well as soldered; the tensile strength of the solder itself is relatively small. When mending leaks in brass or copper vessels, use a patch of the same metal cut to an oval or circular shape; tin the patch and its location, sweat on the patch, and reinforce with more solder in the way described above. A tinplate article can be mended with a disk of the same metal. Small parts can be held with tongs against the other member, after being tinned, and the job completed with the point of the bit. If pliers are used—to hold a job over a gas-ring for instance—beware of the "insulated" ones that have a sleeving over the handle. The insulating material is often inflammable, and may ignite and cause severe burns.

Zinc is a little more trouble to solder. Neat spirits of salts is the best flux—not the killed spirits. Take care not to keep the hot bit too long at one spot, or the zinc itself will melt. We are "between the devil and the deep sea": too hot a bit will melt the zinc, and one insufficiently hot will produce a botched and

dirty joint. The ideal is a nice hot bit, moved quickly along the joint as the solder flows. It must be remembered that the bit has not only to melt the solder; it must also and simultaneously raise the temperature of the joint members sufficiently for the molten solder to adhere to them and become incorporated with the surface. Actually, in a properly soldered joint, the solder is alloyed with or fused to each of the jointing surfaces. A job containing a great deal of metal cools quickly and requires more heat to keep it right for the soldering.

A copper or a brass article can be pre-heated over a gas-ring, or by directing upon it the flame of a blow-lamp. Brass burns quite easily, so care is necessary in heating it. Copper solders readily, but loses heat rapidly on account of its high conductivity. Aluminium is difficult to solder; various proprietary alloys are sold for the purpose, and the maker's directions should be followed in using them. Lead is soldered with a flux of tallow. A tallow candle is rubbed over the cleaned and pared surfaces, and a fifty-fifty solder used. Solder is kept off adjacent parts by painting them with a paste made of lampblack and size. Killed spirits of salts also is used for lead.

When it is necessary to localize the heat at the part being soldered, and to prevent its conduction to another part that might thus become unsoldered, a damp swab can be rested on or twisted around a little way back from the spot being soldered. If too close it will prevent the joint itself being dealt with.

Electrically-heated Bits.—When using an electric soldering-bit the same procedure in cleaning and tinning is followed, except that the bit should seldom need re-tinning; it should not become corroded by overheating and should not, therefore, need the drastic treatment that corrosion necessitates. It will soon lose its brightness, but should retain its smooth surface if properly treated. While heating up or awaiting use it should rest on a 10-in. by 6-in. piece of asbestos laid on the bench or table, and not allowed to rest on the woodwork. Neither should it rest on the edge of the solder pan or on the solder in the pan; heat would be conducted away on the one hand, and the solder eventually spoiled on the other.

After the pan has been used a great deal, the solder left in it becomes dirty and its original composition becomes altered to some extent. It should be melted out over a gas-ring, the pan cleaned out, and new solder used. When a stick of solder gets too short—and becomes too hot—to hold in the hand, it can be gripped with a pair of old pliers or with tongs. When too short for this, put it into the soldering pan. The pan should be insulated from the bench or table-top by a piece of asbestos intervening, or else the woodwork may get scorched.

VICES FOR WOOD- & METAL-WORKING.—A quick-grip vice is an essential fitment for the wood-working bench. It has a "release" that enables the jaws to be opened without the need of rotating the tommy-bar and unscrewing them; when the work is placed in position the vice can be closed upon it, and pressure applied thereafter in the usual way, by screwing up the outer jaw. This is a far better arrangement than the older style of bench grip with one or two wooden screws. The metal vice will cost seven to ten shillings, two or three times as much as the wooden one, but is well worth the outlay.

The bench should have also a good, strong metal-working vice permanently screwed upon its top. One weighing four to five pounds is advisable, and will cost as many shillings. For occasional use a lighter vice can be bought that is attached to a table-top or bench by a clamping screw beneath. We must point out, however, that a vice fixed merely by a clamp is not satisfactory; usually there is provision on top for a nail or a screw to go through a plate into the bench. Without this the vice would pivot on the clamping screw when much leverage was applied to the tommy-bar in closing the jaws.

In conjunction with a bench drilling machine there can be used a small flat vice that holds work to be drilled. This is a very useful adjunct to the drill press. A hand vice is very convenient for many metal-working jobs. Do not buy one whose stem is inserted into a wooden handle; the handle is apt to become loose and prove a nuisance. A pin vice is handy for small work, enabling wire to be gripped and manipulated, as in forming pins

for clock plates and many similar jobs. The pattern recommended is like a vice in miniature; the name is sometimes used for a small chuck having a hole drilled lengthwise through its handle. This last-named tool has many uses, but a proper pin vice is to be preferred for its own particular purpose.

The man who goes in for heavy metal work will find a leg vice very useful. It is screwed at the end of the bench and is further supported by a leg that goes down to the floor or rests upon a block an inch or two from the ground.

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